

December 1987

AN INTERTEC PUBLICATION

Volume 5, Issue 12

# Mobile Radio Technology

The journal of mobile communications technology



1 9 8 8  
**BUYERS'  
GUIDE**





# Base station antennas: A lot of blue sky thinking helped us to develop some very down-to-earth solutions.

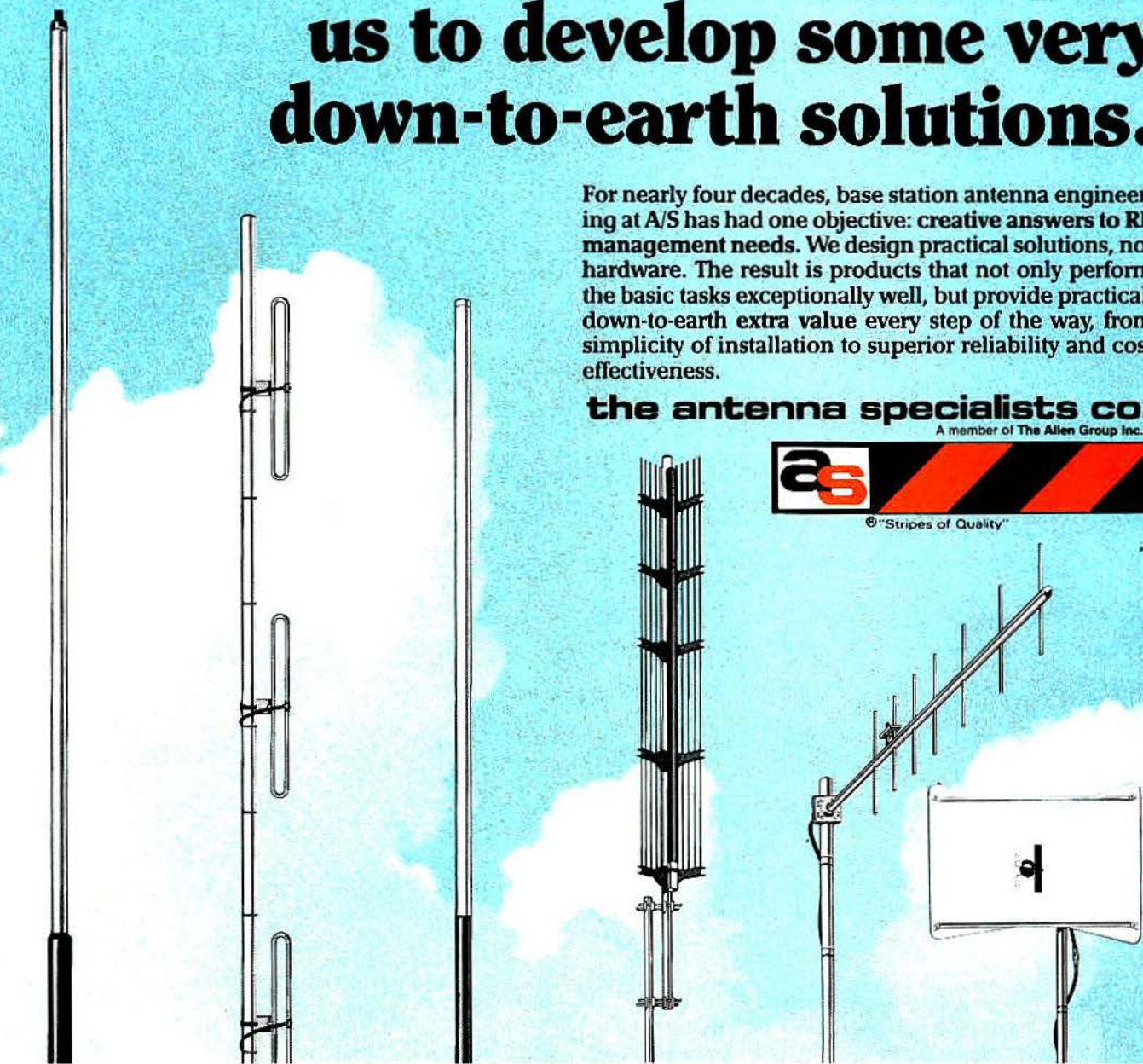
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## Cooperate to solve interference problems

"Can you believe it? An unlicensed user had the gall to complain to us because he was receiving interference from licensed business two-way radio users!"

Thus began one of several unlikely but true stories FCC staff members told during the Land Mobile Interference Workshop the agency's Denver district office held Oct. 15. Field operations bureau members Dennis Carleton, Steve Linn, Leo Cirbo, John Sprague and Rebecca Willman gave presentations, fielded questions and moderated discussions.

Two-way radio and paging system operators, technicians and equipment vendors attended the workshop. What became clear as a result of the information exchange is that interference is not solved by FCC "enforcement," by equipment or by frequency coordination alone. It is solved by cooperation, first among users and frequency coordinators, and second with FCC field operations bureau staff.

### Station ID

Maybe it sounds too simple, but the first step in cooperation is to give station call signs frequently. It is difficult to summarize the station identification rules in a sentence. But roughly speaking, business and industrial users should give their call signs at least every 15 minutes during continuous operation, or during each occasional transmission or exchange of transmissions. The same applies to public safety users, except for a 30-minute requirement during continuous operation.

If automatic station identification equipment is used, it should be set to meet this requirement. And remember, if scrambling or encryption is used, call signs must be given "in the clear."

Station identification is vital because it reveals transmitter loca-

tion and frequency, important facts in resolving interference. "An FCC engineer may have to spend extra time investigating interference because stations involved, or not involved, do not identify as required. The engineer is likely to issue violation notices or, in extreme cases, notices of apparent liability (fines)," one staff member said, "even to the operator who brought the complaint. It is just as important for the complainant to identify properly so his transmissions can be distinguished from others."

### Name that building

Also vital to other users and the FCC investigators alike is the identity of shared and single-user site managers. Every site manager should post his name and phone number outside each equipment building or security fence so extraordinary effort is not required to learn who is using particular sites.

"Aside from tracking interference to business and industrial radio communications," a staff member explained, "sometimes we have a critical need for access to a site because of interference that endangers life or property. We cannot require site managers to post this information. But we urgently request the posting of information that helps us reach someone with 24-hour access to the site. It should be posted where it can be seen outside the facility."

Want to help reduce interference problems? The first two steps are easy. Give your call sign frequently and place signs at your communications sites.

Oh, about that unlicensed user? "We asked him his call sign," the FCC staffer said. "He didn't know what it was. We asked him his frequency. He didn't know that, either. The solution was clear. We put him off the air. No more interference."

—Don Bishop



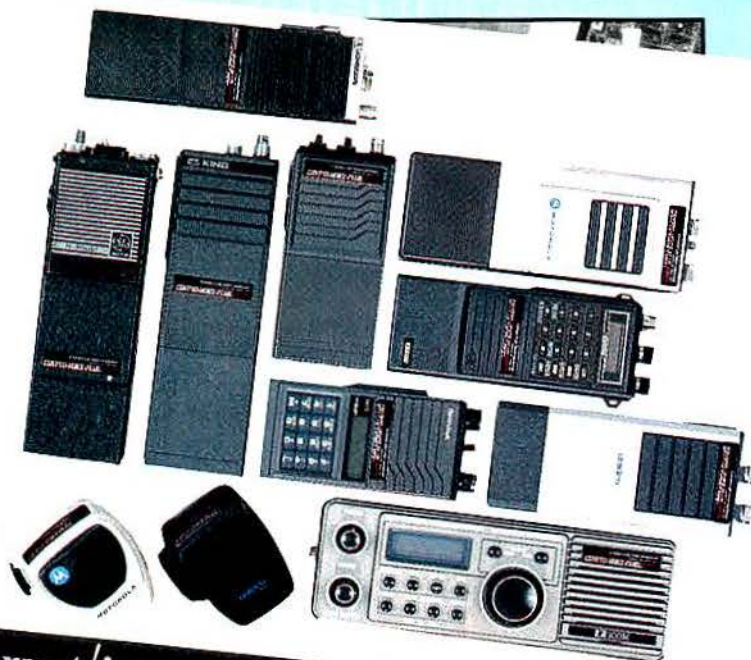
# PRIVACY

NEWS  
from  
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Volume 1, No. 2

## NEW TECHNOLOGY FOR TODAY'S RADIOS

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# letters to the editor

I am not a ham radio operator. In fact, my occupation is in the mobile radio and radio common carrier business. But I am growing increasingly concerned as I hear the FCC is continuing to push for reallocation of the 220MHz ham radio segment.

My opinion of the FCC is declining steadily in the face of its recent radical changes (including institution of fee charges, even for emergency services, as well as hams). But its more recent moves go beyond reason.

If it feels such a compelling need to force reallocation of spectrum upon other users (including UHF commercial broadcasting), then perhaps it should consider reallocating some of the government channels between 150MHz and 174MHz. After all, that particular

segment (of which it has assigned itself 65%) is perhaps the most desirable due to its superior propagation characteristics (nominal atmospheric attenuation, nominal variance due to such random variables as hydrometeors, nominal interference due to "roughness" of terrain, virtually no "skip" and sufficiently short wavelength to enable sky-based antenna structures and gain antennas).

Apparently the bureaucrats were counting on spectrum users as being a silent majority of the voting populace. I think they are beginning to find out otherwise.

Steve Short  
Pocatello, ID

You are doing a great job. I cannot think of any changes that would

greatly improve your publication. Quality and in-depth articles. I am in the public safety sector and so am not very interested in cellular, only what technology it has spawned.

Ronald Blecha  
Nebraska State Patrol,  
radio engineering  
Minden, NE

More on radio frequency interference generated by various sources.

Sanford Meschkow  
ROB Enterprises  
W. Conshohocken, PA

Very good job. Look forward to each issue. Thanks.

K.R. Stevens  
Stevens Radio  
Rochester, NY



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The journal of mobile communications technology

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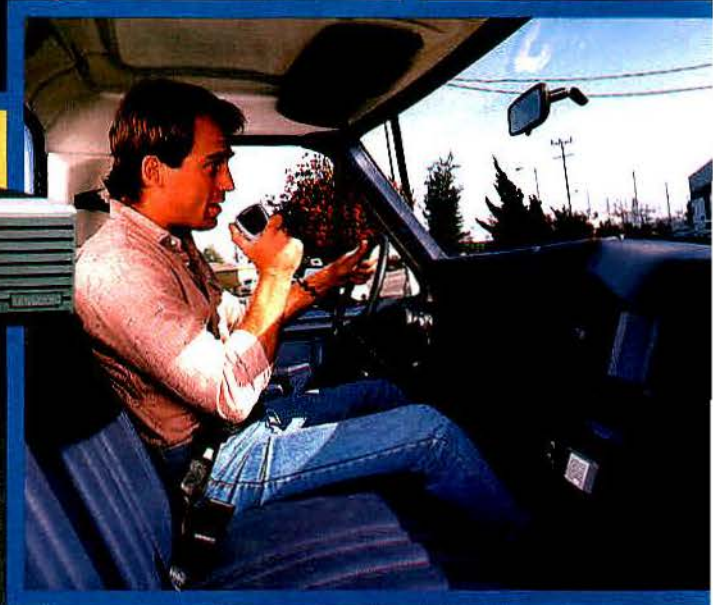
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# The message is clear Kenwood advances communications.



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# KENWOOD

What all the talk is about.

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# 1988 Buyers' Guide

*MRT's annual directory provides you essential information you will want to retain for quick reference year-round. Products and services are listed, as well as trade associations and FCC offices.*

Welcome to the first directory issue of *Mobile Radio Technology*. You will find it a complete product and services source for the mobile radio industry.

We have worked for months with cooperative industry authorities and our editorial advisory board to establish informative categories and to compile data. We mailed questionnaires to suppliers and service companies, and we asked them to list the products and services they offer. This "Buyers' Guide" is designed to be an easily used reference for an entire year. It is divided into five sections: the **Product Directory**, the **Services Directory**, **Company Addresses**, **Trade Associations** and **FCC Offices**.

The **Product Directory** lists more than 150 categories of equipment and suppliers. Under each heading is a comprehensive list of the companies that offer that par-

ticular product. More than 300 companies are listed.

Under the product headings, you will find some companies **listed in blue**. These are advertisers in this issue, and the page numbers serve as reference for additional information directly from the manufacturers, either by contacting them or using the ads' Fast Fact numbers and returning the Fast Fact Card on page 131.

For your convenience, two Fast Fact Cards are bound into this issue. Each card is valid for a full year. By circling the appropriate numbers associated with manufacturers' and services companies' advertisements, you can obtain additional information directly from the product or service source.

The **Services Directory** follows the Product Directory and lists 12 service categories and the companies that provide them. Again, you will find **blue listings** for adver-

tisers that appear in this issue.

Following the product and services directories, you will find an alphabetized index of **Company Addresses**, as well as phone numbers for convenience, for all the companies listed in this "Buyers' Guide." Regional sales contacts are listed for advertisers in this issue.

As part of our directory, *MRT* sorts out the various trade groups in mobile radio in our **Trade Associations** listing. Here you will find the addresses and phone numbers of the numerous trade associations representing mobile radio interests.

**FCC Offices** are listed for your convenience following the industry associations listings.

*MRT's* staff has made every attempt to make this first "Buyers' Guide" accurate and complete. However, because so many suppliers are involved in this field and new entrants always are surfacing, some companies or organizations and products or services may have been overlooked. If yours is one of these companies or organizations, please send your company's name and address during the upcoming year to Pat Blanton, *MRT* Directory Editor, P.O. Box 12901, Overland Park, KS 66212. This will help make next year's "Buyers' Guide" an even better reference.



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- Originate timer (drops line if no dial tone or if call not answered)
- Autoanswer function and default timer (time-out timer)
- Accessible by built-in DTMF or any type of external decoder
- Access security, monitor, and call control

control points to your radio system without the need for multiple leased lines. The system also allows you to install a remote base station at a temporary location, to communicate with field personnel even when they are hundreds of miles away, and to "back up" microwave links or unreliable leased lines inexpensively, without the delay and expense of leased-line installation.

 **Cetec Vega**

Division of Cetec Corporation

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# The Liberator



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For more information on the products and services listed in blue, turn to the page listed with the entry to find the company's advertisement. Note the Fast Fact number assigned to the advertisement, and circle this number on the Fast Fact Card on page 131 in this issue and return the card to MRT. See example at right. The cards are valid for one year.

**Mobile Radio Technology**

FOR FASTER ACTION!!!

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Omnicon Electronic	117
Penta Corp.	
Positron Industries, Inc.	28
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Repeo Inc.	39
Ritron Inc.	
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Speedcall Corp.	
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Heliopower Inc.	
M. Hutton & Co.	16
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Solarex	
Wisco International Ltd.	

### Thermoelectric

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Wisco International Ltd.	

### Wind

ROHN	
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Beam Radio Inc.	58
Cablewave Systems	
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Cellular Depot Inc.	
Cellular Design Corp.	
Celwave	17
Communications Associates, Inc.	14
Decibel Products, Inc.	44
D&R Associates, Inc.	
Electronic Products Inc.	
Fabrecon Development Corp.	
Fort Worth Tower Co., Inc.	
General Electric Co.	
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Hawa Systems USA Inc.	43
Hustler, Inc.	
M. Hutton & Co.	16
Kathrein Inc.	62
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Meridian Communications, Inc.	
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Motorola Inc., Communications Sector	
NCG Companies	
Primus Electronics Corp.	128
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Scala Electronic Corp.	62
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Signals Communications Corp.	
Sinclair Radio Labs Inc.	
Sti-Co Industries	127
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Tessco	21
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Les Wallen USA	

## ANTENNA SITE EQUIPMENT

### Cavity Filters

AAT Communications Corp.	
The Antenna Farm, Inc.	
Antenna Specialists Co.	IFC
Beam Radio Inc.	58

Cartwright Communications Co.	
Celwave	17
Communications Associates, Inc.	14
Decibel Products, Inc.	44
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Kathrein Inc.	62
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M/A-COM Land Mobile Communications	
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Primus Electronics Corp.	128
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Secom Systems	
Sinclair Radio Labs Inc.	
Telewave, Inc.	67
Tessco	21
Texscan Instruments Div.	
TX RX Systems Inc.	108,109
Wacom Products Inc.	
Wisco International Ltd.	

### Combiners (Transmitter)

AAT Communications Corp.	
Acraim Inc.	
The Antenna Farm, Inc.	
Antenna Specialists Co.	IFC
Beam Radio Inc.	58
Cartwright Communications Co.	
Celwave	17
Communications Associates, Inc.	14
Decibel Products, Inc.	44
D&R Associates, Inc.	
Electronic Products Inc.	
EMR Corp.	36
M. Hutton & Co.	16
Kathrein Inc.	62
LeBlanc & Royle Telcom Inc.	
M/A-COM Land Mobile Communications	
Meridian Communications, Inc.	
Motorola Inc., Communications Sector	
Primus Electronics Corp.	128
Scala Electronic Corp.	62
Secom Systems	
Sinclair Radio Labs Inc.	
Telewave, Inc.	67
Tessco	21
TX RX Systems Inc.	108,109
Wacom Products Inc.	
Wisco International Ltd.	





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Circle (11) on Fast Fact Card

## Duplexers (Repeaters)

AAT Communications Corp.	
Air Comm	
The Antenna Farm, Inc.	
Antenna Specialists Co.	IFC
Beam Radio Inc.	58
Cartwright Communications Co.	
Celwave	17
Communications Associates, Inc.	14
The Communications Center	
Decibel Products, Inc.	44
D&R Associates, Inc.	
Electronic Products Inc.	
EMR Corp.	36
M. Hutton & Co.	16
E.F. Johnson	
Kathrein Inc.	62
LeBlanc & Royle Telcom Inc.	
M/A-COM Land Mobile Communications	
Meridian Communications, Inc.	
Motorola Inc., Communications Sector	
Primus Electronics Corp.	128
Scala Electronic Corp.	62
Secom Systems	
Sinclair Radio Labs Inc.	
Spectrum Communications Corp.	135
Tait Electronics USA, Inc.	106,143
Telemobile Inc.	
Telewave, Inc.	67
Tessco	21
TX RX Systems Inc.	108,109
Wacom Products Inc.	
Wisco International Ltd.	

## Hybrid Couplers

AAT Communications Corp.	
The Antenna Farm, Inc.	
Antenna Specialists Co.	IFC
Beam Radio Inc.	58
Cartwright Communications Co.	
Celwave	17
Communications Associates, Inc.	14
Decibel Products, Inc.	44
D&R Associates, Inc.	
Electronic Products Inc.	
EMR Corp.	36
M. Hutton & Co.	16
Kathrein Inc.	62
LeBlanc & Royle Telcom Inc.	
M/A-COM Land Mobile Communications	
Meridian Communications, Inc.	
Motorola Inc., Communications Sector	
NGC Companies	
Scala Electronic Corp.	62
Secom Systems	
Sinclair Radio Labs Inc.	
Telewave, Inc.	67
TX RX Systems Inc.	108,109
Wacom Products Inc.	
Wisco International Ltd.	

## Isolators and Circulators

AAT Communications Corp.	
Air Comm	
The Antenna Farm, Inc.	
Antenna Specialists Co.	IFC
Beam Radio Inc.	58
Cartwright Communications Co.	
Celwave	17
Communications Associates, Inc.	14
Decibel Products, Inc.	44
D&R Associates, Inc.	

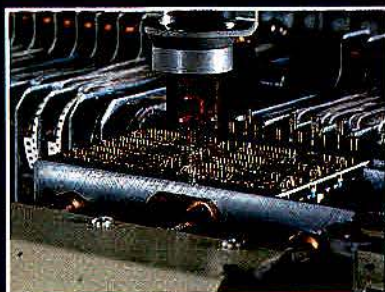


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For more information about ICOM's UHF and VHF radios, contact ICOM America, Inc. corporate headquarters or your local ICOM dealer.



**IC-U16 UHF**  
**IC-H16 VHF (not shown)**



**IC-U400 UHF**  
**IC-V100 VHF (not shown)**



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214-484-0580 800-442-3811

Circle (13) on Fast Fact Card

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Electronic Products Inc.	
EMR Corp.	36
M. Hutton & Co.	16
Kathrein Inc.	62
LeBlanc & Royle Telcom Inc.	
M/A-COM Land Mobile Communications	
Meridian Communications, Inc.	
Motorola Inc., Communications Sector	
Primus Electronics Corp.	128
Scala Electronic Corp.	62
Secom Systems	
Sinclair Radio Labs Inc.	
Telewave, Inc.	67
Tessco	21
TX RX Systems Inc.	108,109
Wacom Products Inc.	
Wisico International Ltd.	

#### Multicouplers (Receiver)

AAT Communications Corp.	
Advanced Receiver Research	98
The Antenna Farm, Inc.	
Antenna Specialists Co.	1FC
Beam Radio Inc.	58
Cartwright Communications Co.	
Celwave	17
Communications Associates, Inc.	14
Decibel Products, Inc.	44
D&R Associates, Inc.	
Electronic Products Inc.	
EMR Corp.	36
M. Hutton & Co.	16
Kathrein Inc.	62
LeBlanc & Royle Telcom Inc.	
Lunar Industries	110
M/A-COM Land Mobile Communications	
Meridian Communications, Inc.	
Motorola Inc., Communications Sector	
Primus Electronics Corp.	128
Scala Electronic Corp.	
Secom Systems	
Sinclair Radio Labs Inc.	
Telewave, Inc.	67
Tessco	21
TX RX Systems Inc.	108,109
Wacom Products Inc.	
Wisico International Ltd.	

#### Pre-amplifiers (Receiver)

AAT Communications Corp.	
Advanced Receiver Research	98
The Antenna Farm, Inc.	
Antenna Specialists Co.	1FC
Beam Radio Inc.	58
Cartwright Communications Co.	
Celwave	17
Communications Associates, Inc.	14
Decibel Products, Inc.	44
D&R Associates, Inc.	
Electronic Products Inc.	
EMR Corp.	36
Hawa Systems USA Inc.	43
M. Hutton & Co.	16
Janel Labs Inc.	
LeBlanc & Royle Telcom Inc.	
Lunar Industries	110
Meridian Communications, Inc.	
Motorola Inc., Communications Sector	
Secom Systems	
Sinclair Radio Labs Inc.	
Telewave, Inc.	67
TX RX Systems Inc.	108,109

Wacom Products Inc.  
Wisico International Ltd.

#### Other

Bally Engineered Structures, Inc.	
Beam Radio Inc.	58
Cartwright Communications Co.	
Climate-Tel	
Decibel Products, Inc.	44
Electronic Products Inc.	
EMR Corp.	36
Janel Labs Inc.	
Kathrein Inc.	62
Microflex Co., Inc.	136
Moseley Associates, Inc.	113
Motorola Inc., Communications Sector	
Scala Electronic Corp.	62
Sinclair Radio Labs Inc.	
Telewave, Inc.	67
TX RX Systems Inc.	108,109
Wacom Products Inc.	
Wisico International Ltd.	

#### ANTENNAS, CELLULAR

##### Base

AAT Communications Corp.	
Andrew Corp.	
Anixter Bros., Inc.	
The Antenna Farm, Inc.	
Antenna Specialists Co.	1FC
Bogner Broadcast Equipment Corp.	54
Cartwright Communications Co.	
Celwave	17
Communications Associates, Inc.	14
Cushcraft Corp.	
Decibel Products, Inc.	44
D&R Associates, Inc.	
Fabrecon Development Corp.	
Fort Worth Tower Co., Inc.	
General Electric Co., Mobile Communications Business Div.	
M. Hutton & Co.	16
Kathrein Inc.	62
Larsen Electronics, Inc.	35
LeBlanc & Royle Telcom Inc.	
Mark Antennas Div., Radiation Systems Inc.	
Maxrad Inc.	102
Meridian Communications, Inc.	
Motorola Inc., Communications Sector	
National Car Phones	
NGC Companies	
NovAtel Communications Ltd.	
Path Products	
Primus Electronics Corp.	128
R F Products	
Scala Electronic Corp.	62
Secom Systems	
Signals Communications Corp.	
Sinclair Radio Labs Inc.	
Telewave, Inc.	67
Telular	85
Tessco	21
Two Comm Inc.	
Les Wallen USA	
Western Mobile Telephone	
Wisico International Ltd.	

##### Mobile

AAT Communications Corp.



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Maxon Electronics, Airworld Center Complex, 10723 Ambassador Dr., Kansas City, MO 64153, USA.

\* 810D supercedes 810C

See Adv. Page

American Mobile Communications of Florida, Inc.	
Anixter Bros., Inc.	
The Antenna Farm, Inc.	
Antenna Specialists Co.	IFC
ARA Mfg. Co.	
Cartwright Communications Co.	
Cellular Communications Corp.	
Celwave	17
Comm 88	
Communications Associates, Inc.	14
Communications Signalling	
Cushcraft Corp.	
Decibel Products, Inc.	44
D&R Associates, Inc.	
Drive Phone Inc.	
Electronic Products Inc.	
General Electric Co., Mobile Communications Business Div.	
Harada Industry of America	
Hustler, Inc.	
M. Hutton & Co.	16
Larsen Electronics, Inc.	35
LeBlanc & Royle Telcom Inc.	
Maxrad Inc.	102
Meridian Communications, Inc.	
Mobile Mark Inc.	111
Modublox & Co., Inc.	133
Motorola Inc., Communications Sector	
National Car Phones	
NCG Companies	
NovAtel Communications Ltd.	
ORA Electronics	IBC
Primus Electronics Corp.	128
Railfone, Inc., Sub. of GTE Airfone, Inc.	
Repeco Inc.	39
R F Products	
Scientific Dimensions Inc.	
Secom Systems	
Signals Communications Corp.	
Sinclair Radio Labs Inc.	
Speco Components	
TAC	
Tessco	21
Two Comm Inc.	
Les Wallen USA	
Western Mobile Telephone	
Wisico International Ltd.	

## Portable

AAT Communications Corp.	
Anixter Bros., Inc.	
The Antenna Farm, Inc.	
Antenna Specialists Co.	IFC
Cartwright Communications Co.	
Cellular Communications Corp.	
Celwave	17
Centurion International, Inc.	29
Comm 88	
Communications Associates, Inc.	14
Communications Signalling	
Cushcraft Corp.	
D&R Associates, Inc.	
Drive Phone Inc.	
Electronic Products Inc.	
General Electric Co., Mobile Communications Business Div.	
Harada Industry of America	
M. Hutton & Co.	16
Kenwood USA Corp.	7
Larsen Electronics, Inc.	35
LeBlanc & Royle Telcom Inc.	

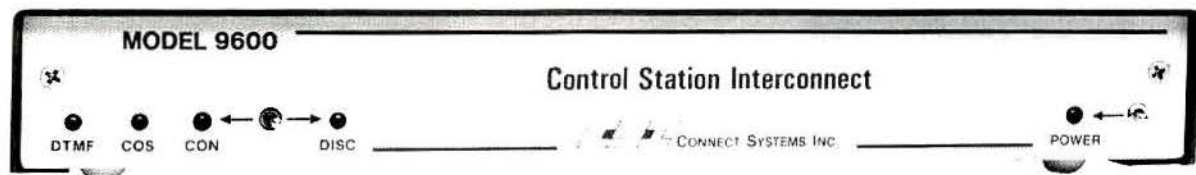


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- Secret toll override code
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- Dialtone disconnect
- CW identification
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- Timeout timer (resettable by mobile)
- Telephone initiated control
- Telephone controlled switch
- Regenerated DTMF selective calling
- Ringout
- Ringout or auto answer on 1-8 rings
- Busy channel ringout inhibit
- Patch status messages
- Internally squelched audio
- MOV lightning protection
- Front panel status LED's
- COS polarity reversal
- Keypad compatible
- 12 VDC powered

24 dip switches make all 9600 features programmable/selectable.

Additional features are too numerous to list. Please call or write today for your free four page brochure.

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- CW ID chip
- FCC registered coupler

## CSI POLICY

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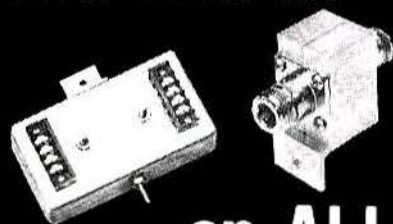
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Telex: 272718

Circle (17) on Fast Fact Card

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<b>Maxrad Inc.</b>	102
Meridian Communications, Inc.	
<b>Modublox &amp; Co., Inc.</b>	133
Motorola Inc., Communications Sector	
NCG Companies	
Novatel Communications Ltd.	
<b>ORA Electronics</b>	IBC
<b>Primus Electronics Corp.</b>	128
R F Products	
Scientific Dimensions Inc.	
Secom Systems	
Signals Communications Corp.	
Sinclair Radio Labs Inc.	
TAC	
<b>Tessco</b>	21
Two Comm Inc.	
Les Wallen USA	
Western Mobile Telephone	
Wisco International Ltd.	
<b>W &amp; W Associates, (Batteries 'R' US)</b>	123

#### ANTENNAS, MICROWAVE

Andrew Corp.	
Anixter Bros., Inc.	
The Antenna Farm, Inc.	
Cablewave Systems	
Fort Worth Tower Co., Inc.	
General Electric Co.	
Jefa International, Inc.	
LeBlanc & Royle Telcom Inc.	
Mark Antennas Div., Radiation Systems Inc.	
Microwave Networks Inc.	
Motorola Inc., Communications Sector	
NCG Companies	
Path Products	
<b>Telewave, Inc.</b>	67
Wisco International Ltd.	

#### ANTENNAS, MTS, IMTS

##### Base

Anixter Bros., Inc.	
The Antenna Farm, Inc.	
<b>Antenna Specialists Co.</b>	IBC
<b>Bogner Broadcast Equipment Corp.</b>	54
Cartwright Communications Co.	
<b>Celwave</b>	17
<b>Decibel Products, Inc.</b>	44
D&R Associates, Inc.	
<b>Hawa Systems USA Inc.</b>	43
<b>M. Hutton &amp; Co.</b>	16
<b>Kathrein Inc.</b>	62
<b>Larsen Electronics, Inc.</b>	35
LeBlanc & Royle Telcom Inc.	
<b>Maxrad Inc.</b>	102
Meridian Communications, Inc.	
Motorola Inc., Communications Sector	
NCG Companies	
R F Products	
<b>Scala Electronic Corp.</b>	62
Secom Systems	
Signals Communications Corp.	
Sinclair Radio Labs Inc.	
Telemobile Inc.	
<b>Telewave, Inc.</b>	67
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Two Comm Inc.	
Western Mobile Telephone	
Wisco International Ltd.	

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#### Portable

The Antenna Farm, Inc.	
<b>Antenna Specialists Co.</b>	IBC
Cartwright Communications Co.	
<b>Centurion International, Inc.</b>	29
D&R Associates, Inc.	
Electronic Products Inc.	
<b>Hawa Systems USA Inc.</b>	43
<b>M. Hutton &amp; Co.</b>	16
<b>Larsen Electronics, Inc.</b>	35
LeBlanc & Royle Telcom Inc.	
<b>Maxrad Inc.</b>	102
Meridian Communications, Inc.	
<b>Modublox &amp; Co., Inc.</b>	133
Motorola Inc., Communications Sector	
NCG Companies	
R F Products	
Scientific Dimensions Inc.	
Secom Systems	
Signals Communications Corp.	
Sinclair Radio Labs Inc.	
Telemobile Inc.	
<b>Tessco</b>	21
Two Comm Inc.	
Western Mobile Telephone	
Wisco International Ltd.	

#### ANTENNAS, PAGING

AAT Communications Corp.	
Anixter Bros., Inc.	
The Antenna Farm, Inc.	
<b>Antenna Specialists Co.</b>	IBC
<b>Beam Radio Inc.</b>	58
<b>Bogner Broadcast Equipment Corp.</b>	54
Cartwright Communications Co.	
<b>Celwave</b>	17
<b>Communications Associates, Inc.</b>	14
Cushcraft Corp.	
<b>Decibel Products, Inc.</b>	44
D&R Associates, Inc.	
Electronic Products Inc.	
<b>Hawa Systems USA Inc.</b>	43
Hustler, Inc.	
<b>M. Hutton &amp; Co.</b>	16
<b>Kathrein Inc.</b>	62
LeBlanc & Royle Telcom Inc.	
Mark Antennas Div., Radiation Systems Inc.	
Meridian Communications, Inc.	
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Motorola Inc., Communications Sector	
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#### ANTENNAS, TWO-WAY DISPATCH, SMR

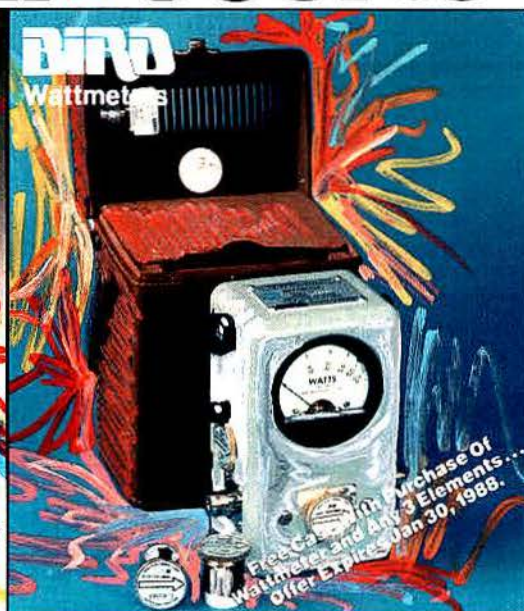
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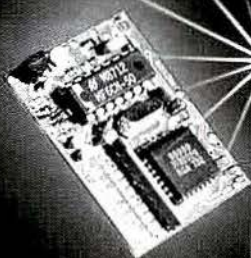
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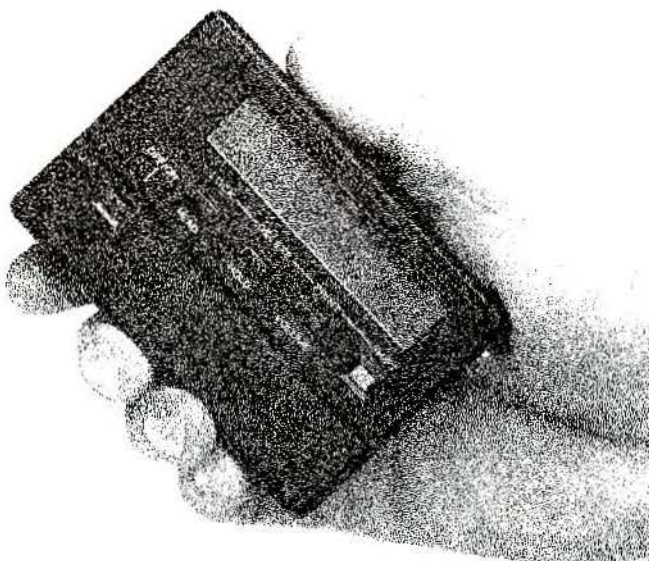
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In 1982 we challenged the land mobile industry with a new kind of 2-way FM radio: the frequency-synthesized Midland Syn-Tech™. It was to ordinary radios what the PC was to adding machines. It had much more capability than existing radios, cost less than anything remotely comparable, and its E/PROM-controlled microcomputer was field programmable.

These advantages revolutionized both the distribution and use of two-way radio. For the first time, users could have a compact, affordable, high-capability radio, tailored specifically to their requirements by their local two-way dealer.

**Instant radio, exactly to your needs.** Today, with a few basic models and a handful of option kits a Midland dealer can program and deliver a Syn-Tech—mobile, portable or base station—virtually off the shelf. From one to 80 channels. Channel scanning. Choice of priority and scan mode. CTCSS and DCS squelch. DTMF. Wideband options and considerably more.



**Protection from obsolescence.** Syn-Tech radios are designed for change. Not only can an authorized technician change the radio's entire "personality" in as little as 10 minutes, but all the capability enhancements developed since 1982 are retrofittable to the first Syn-Tech ever introduced.

**Outstanding Reliability.** Syn-Tech radios are like having "communications insurance." Since we introduced the radios, they've averaged fewer than 1% "infant mortality" failures and life test results correspond to a unit availability of better than 99% on a normal annual operational schedule.

**More help from your dealer.** Time he used to spend fixing radios he can now devote to helping you. Learning your requirements. Planning the right system. Helping you with financing or leasing. Programming your radios. Or modifying your system as your needs change or grow.

## has made believers out of...

**Some pretty tough customers** accepted the Midland challenge. They compared capability and specs with other radios. They did intensive side-by-side field tests with evaluation units. They put them on shake tables. They compared price. Then they put them to work. In 1982 it took guts to switch two-way radio brands. Now it only takes common sense.





# Challenge...



## "Superior reliability"

"Radios in our off-road land survey vehicles really take a beating. But the reliability of our Syn-Tech's has proven far superior to anything else I've experienced in 12 years as a two-way user."

Charles Sterling, President  
Sterling Engineering, Inc.  
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"The large channel capacity, plus the ability to reprogram the Syn-Tech quickly, means I can operate anywhere in or out of my service territory on an instant's notice."

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Kansas City, MO Fire Department



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Ronald H. Quinter, Chief  
Womelsdorf Borough Police  
Womelsdorf, PA

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Wisco International Ltd.

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JaBro Batteries, Inc.	
Kyocera America	
Motorola Inc., Communications Sector	



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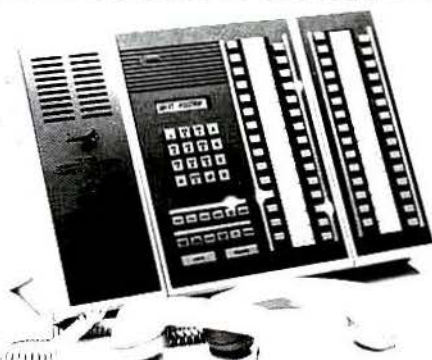


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Based on a completely distributed microprocessor architecture, TRCC\* offers maximum flexibility. Custom configuration of each system to meet your communication needs.

## Features include:

- Programmability
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### FEATURES:

- BUILT IN R.F. AMPLIFIER
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- EXTERNAL AUDIO JACK
- FAST CHARGER
- ALL CONNECTIONS MADE WITH ONE SLIDING LEVER.
- CONSTRUCTED TO COMPLIMENT THE KING RADIO LINE.



### PRODUCT SPECIFICATIONS

R.F. Amplifier:	30 Watts VHF, 20 Watts UHF, 20 Watts, 800 MHZ
Audio Amplifier:	8 Watts to External Speaker Jack, 5 Watts to Internal Speaker
Charger:	Automatic Thermal Sensing, 3 Hour Fast Charge, Normal Charge
Input Voltage:	12.2 VDC to 15.0 VDC
Current Drain:	5 Amps when Transmitting
Connections:	Automatic through Sliding Contact Block
Dimensions:	8"W x 2 1/4"H x 9 1/2"D
Weight:	3 Pounds
Operating Temp.:	-30° to +60°C
Indicators:	Led Indicators for Audio On, Fast and Normal Charge, R.F. On
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FAX: 213-254-3210

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## CASES FOR PORTABLE EQUIPMENT

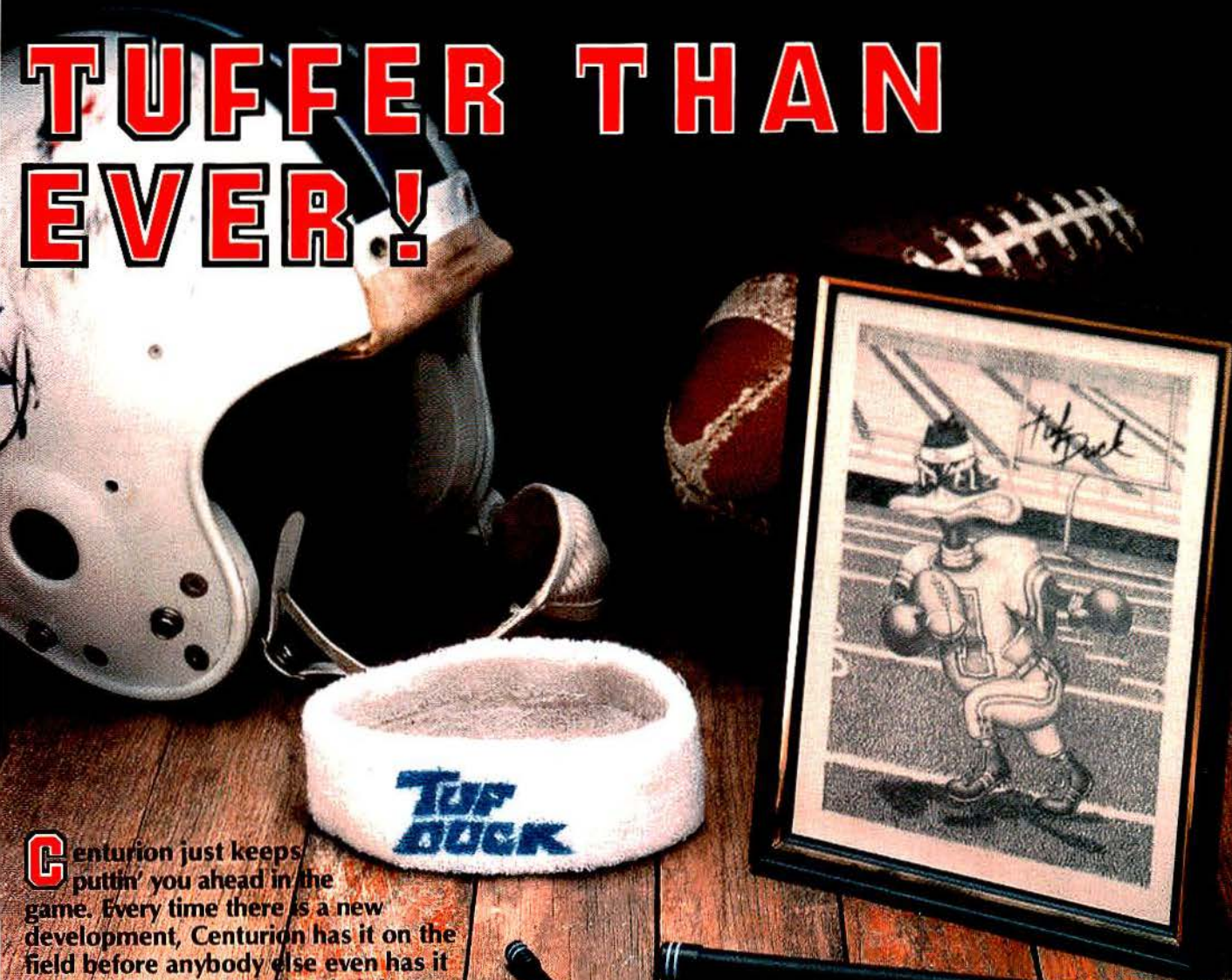
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# NEW TUFFER THAN EVER!



**C**enturion just keeps puttin' you ahead in the game. Every time there is a new development, Centurion has it on the field before anybody else even has it in the play book. And they do it better.

Take these new molded antennas from Centurion. Tough. Sleek. Smooth. And downright good lookin', too. (Kinda remind me of a certain duck I know!)

Centurion makes four styles of these EX Series molded portable radio antennas. They don't let a drop of moisture in, so they're great for use in adverse conditions. And they meet the spec's for most intrinsically safe and "ruggedized" radios.

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**TUF  
DUCK**





# Above and Beyond AR2002

PROFESSIONAL MONITOR RECEIVER

25 - 550 MHz

800 - 1300 MHz



## Specifications:

Receiving mode - Narrow band FM, Wide band FM & AM

Receiver circuit - Microprocessor controlled PLL  
Frequency synthesized superheterodyne type  
with high-level doubled balanced mixer

Receiver IF - 750MHz, 45.03MHz, 5.5 MHz (WFM)  
and 455kHz (NFM & AM)

Sensitivity - NFM - 0.35  $\mu$ V (12dB SINAD)  
WFM - 1.00  $\mu$ V (12dB SINAD)  
AM - 1.00  $\mu$ V (10dB S/N)

Selectivity - NFM -  $\pm$  7.5kHz @ 6dB  
 $\pm$  20kHz @ 70dB  
WFM -  $\pm$  50kHz @ 6dB  
 $\pm$  250kHz @ 60dB  
AM -  $\pm$  5.0kHz @ 6dB  
 $\pm$  10kHz @ 70dB

Number of memory channel - 20 channels

Scan rate - 5 channels per second

Search rate - 6 seconds per MHz

Antenna connector - Standard BNC type, 50-ohm

Audio output power - 1 watt at less than 10% THD.

Power requirement - 12 to 14Vdc at 300 to 500mA

Size and weight - 5.4"W x 3.15"H x 7.88"D, 2.6 lbs.

## Options:

Cradled mobile mounting bracket

Trunk lid mobile antenna with 12 ft cable

Discone base antenna with 30 ft cable

RS-232C Interface unit

**Please: No Dealer Inquiries**

**AR2002**

Professional Monitor Receiver

**\$455.00**

(California res. add \$27.30 tax)

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**ACE communications, inc.**

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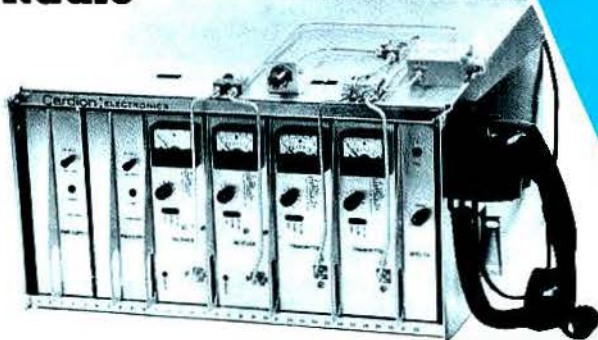
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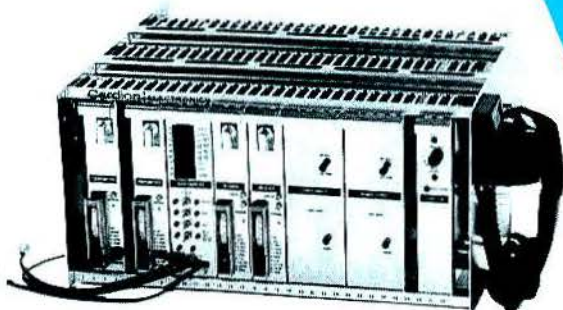


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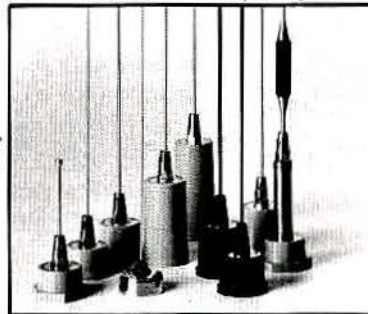
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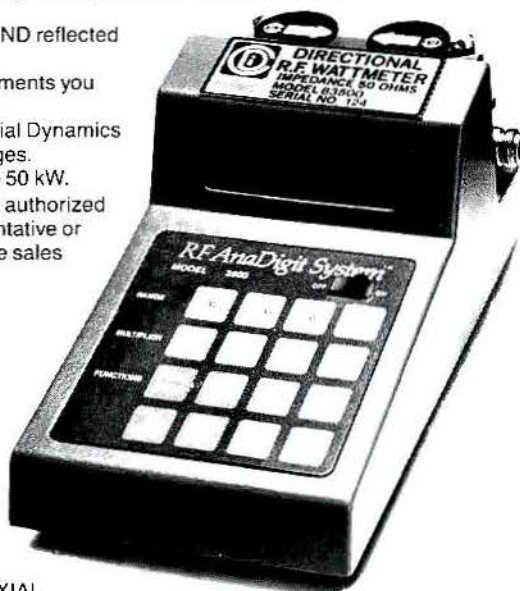
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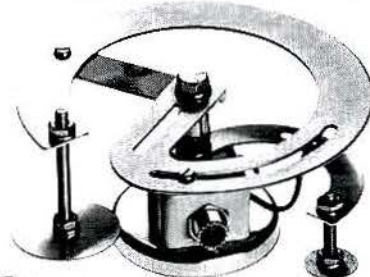
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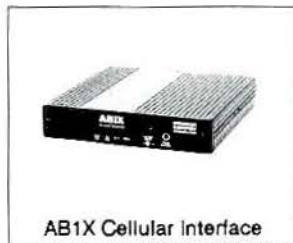
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- fax machines
- laptop computers
- alarm systems
- higher quality hands-free
- signal strength monitoring
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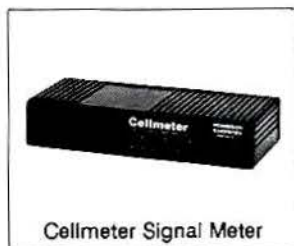
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AB2X Error-Free Modem



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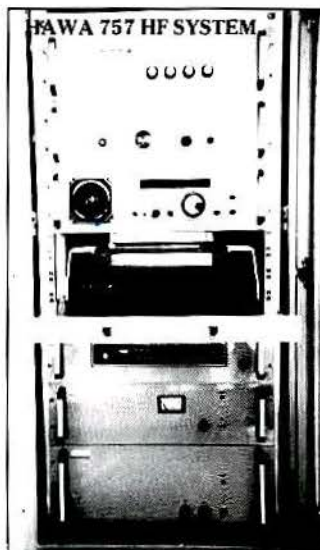
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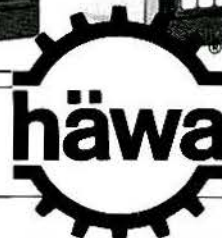
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Auto Page Inc.	
CUE Nationwide Paging	

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## Pike & Fischer's Private Radio Rules Service

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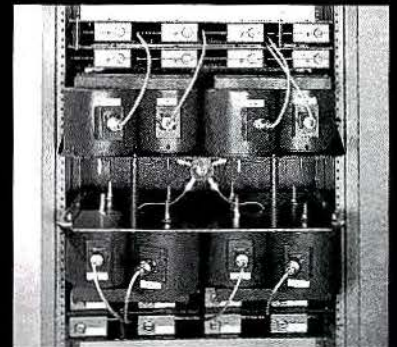
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Company

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Phone  Area Code

MR127C



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The Communications Center	
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**Digital Printing Pagers**

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Wisco International Ltd.	

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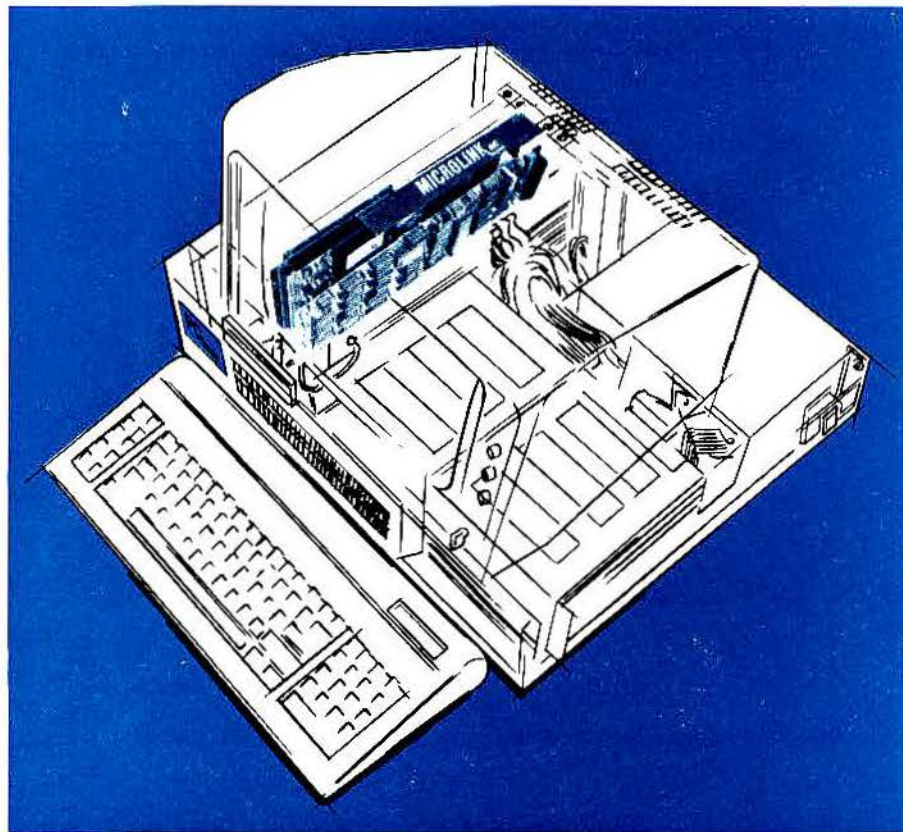


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Reach Electronics, Inc.	
Sonar Radio Corp.	
Stantel Information Systems	
Stantel Telecommunications Inc.	
Telefind Corp.	87
Wisco International Ltd.	

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Secom Systems	
Shinwa Tsushinki Co., Ltd.	
Syntec Communications Systems	
Tekk Inc.	
Telemobile Inc.	

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AND  
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## **NOISE ATTENUATING HEADSET.**



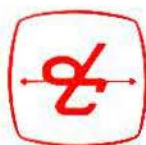
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Industries	The Communications Center	Telecommunications Div.
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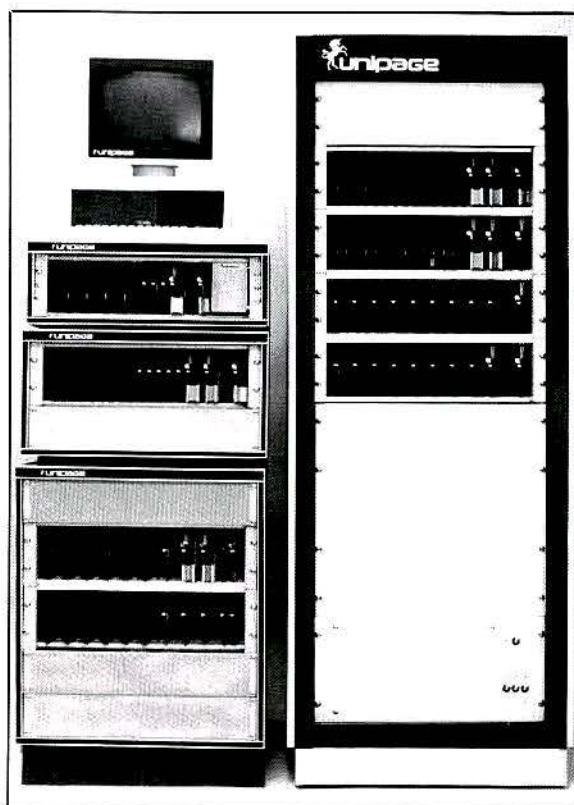
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Circle (50) on Fast Fact Card



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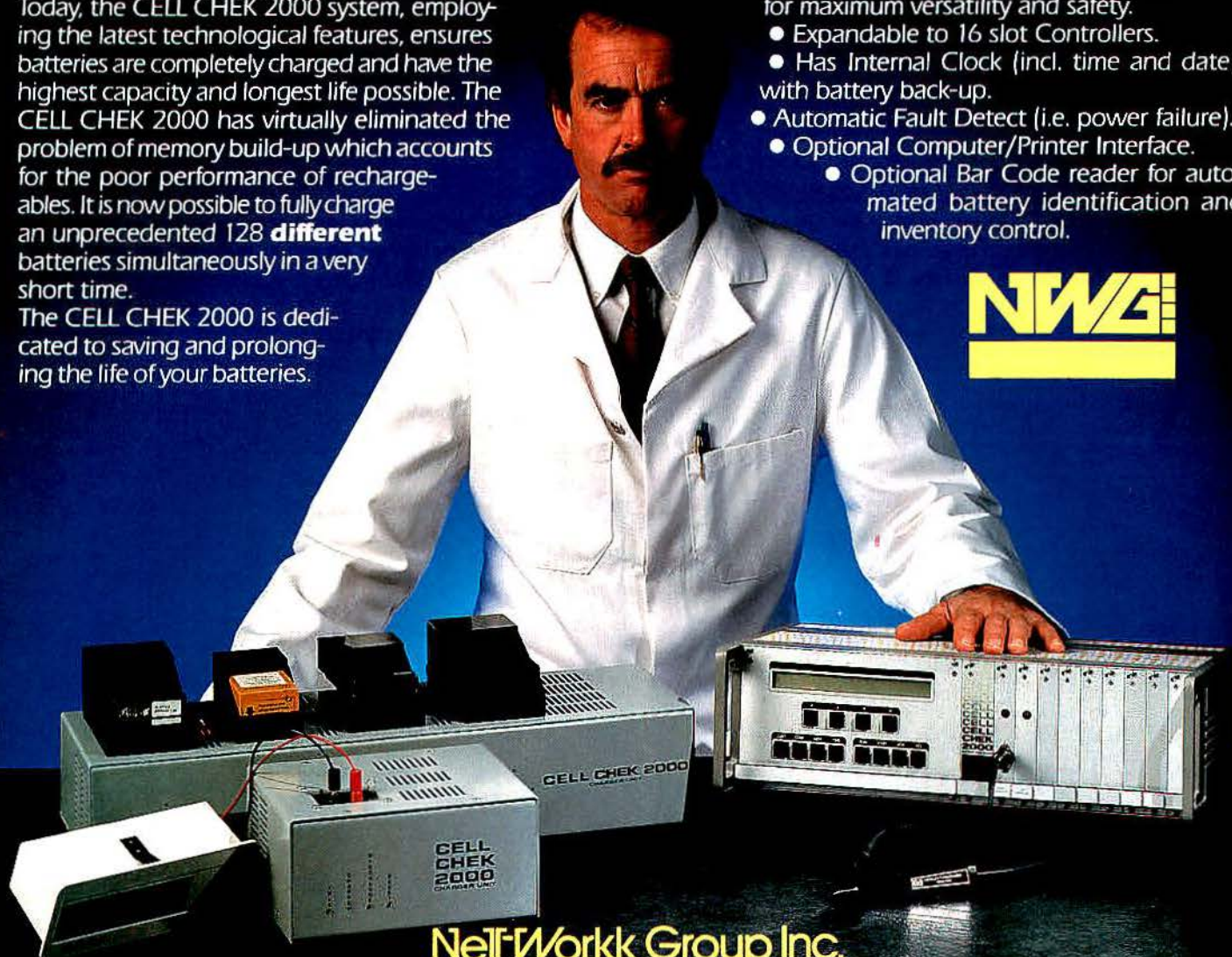
In most cases a weak or dead battery is just an inconvenience. But in an emergency situation, the outcome could be tragic, even fatal. Reliability, the expense of battery replacement and equipment down time, are serious concerns with rechargeables. Until now.

Today, the CELL CHEK 2000 system, employing the latest technological features, ensures batteries are completely charged and have the highest capacity and longest life possible. The CELL CHEK 2000 has virtually eliminated the problem of memory build-up which accounts for the poor performance of rechargeables. It is now possible to fully charge an unprecedented 128 **different** batteries simultaneously in a very short time.

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Circle (52) on Fast Fact Card



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Jeff Levy, President, Mobile Telecommunications Inc.

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ENTREPRENEUR magazine June 1986

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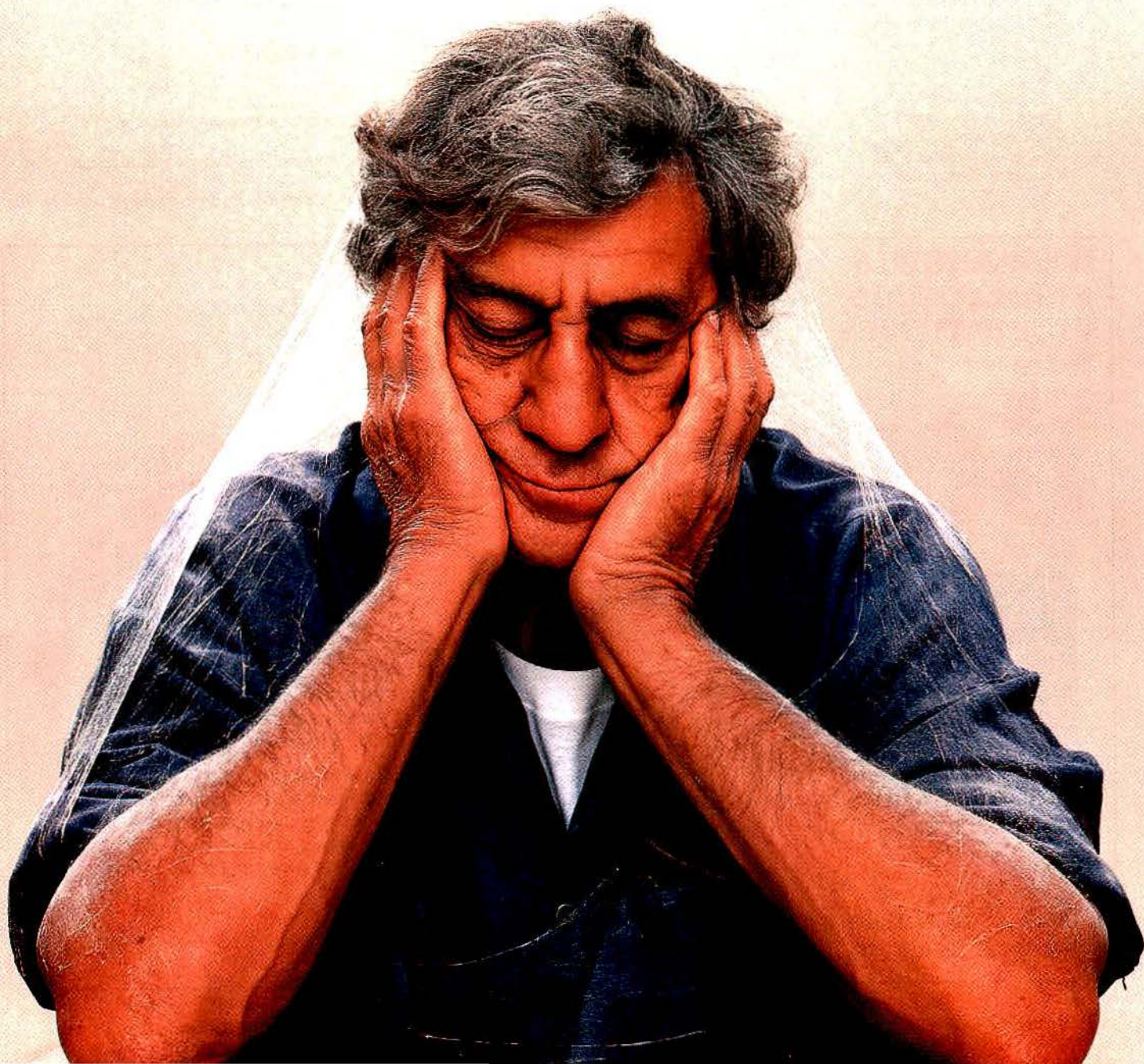


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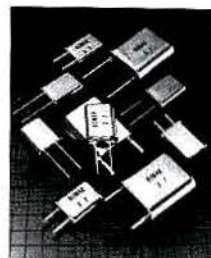
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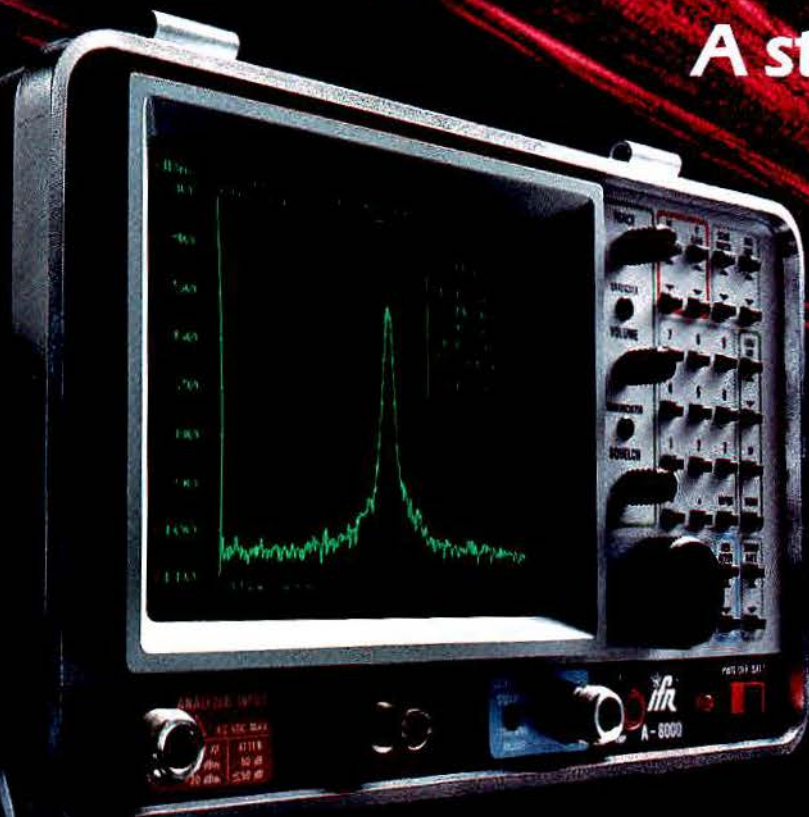
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*Unprecedented Performers!*

# The A-8000 Spectrum Analyzer.

## A step beyond the A-7550.



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- \*Optional Features Include:**
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**IFR SYSTEMS, INC.**

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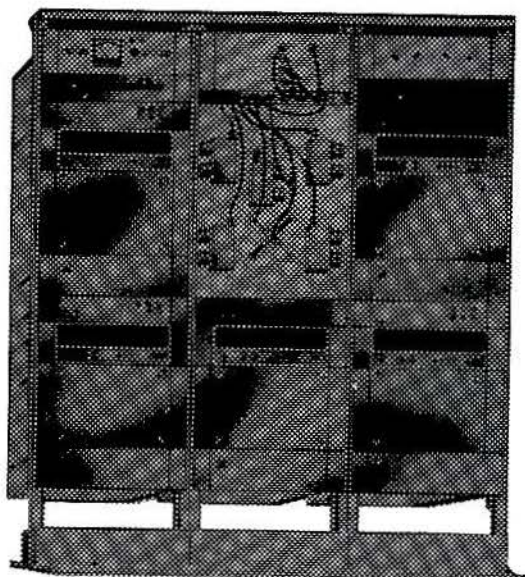
Advanced Systems For Cellular	
Celltech, Inc.	
Cellular Business Systems, Div. of CBIS	
Communications Software, Inc.	
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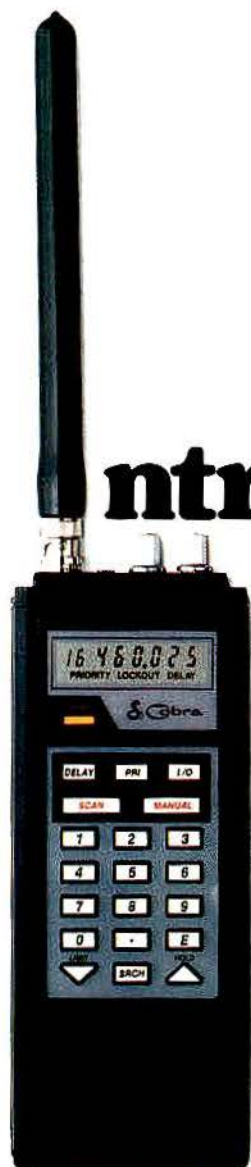
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And get all the scoop much too long to scan here.



Cobra Consumer Electronics Group, 6500 W Cortland, Chicago, IL 60635

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General Electric Co.  
Weinschel Engineering

**Records**

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Cellular Business Systems, Div. of CBIS  
Command Data Systems  
General Electric Co.  
Itron Inc.  
Railfone, Inc., Sub. of GTE Airfone, Inc.

**Service**

Advanced Systems For Cellular  
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ADC Telecommunications, Inc.  
The Antenna Farm, Inc.

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# CELLSMART INC.

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patent pending

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Put some extra "life" into your profits and your customers' car phones with the LifeLine 1000 emergency power-pack back-up system! . . . the power to call when your car battery's down. LifeLine 1000 is specifically designed to provide the necessary 12 volt operating current to a car phone in those instances when a car battery can't supply sufficient power. All of your customers will have peace of mind in an emergency when you equip them with a LifeLine 1000!

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- Works with most NAM-based cellular phones!

Cellular Product Innovations

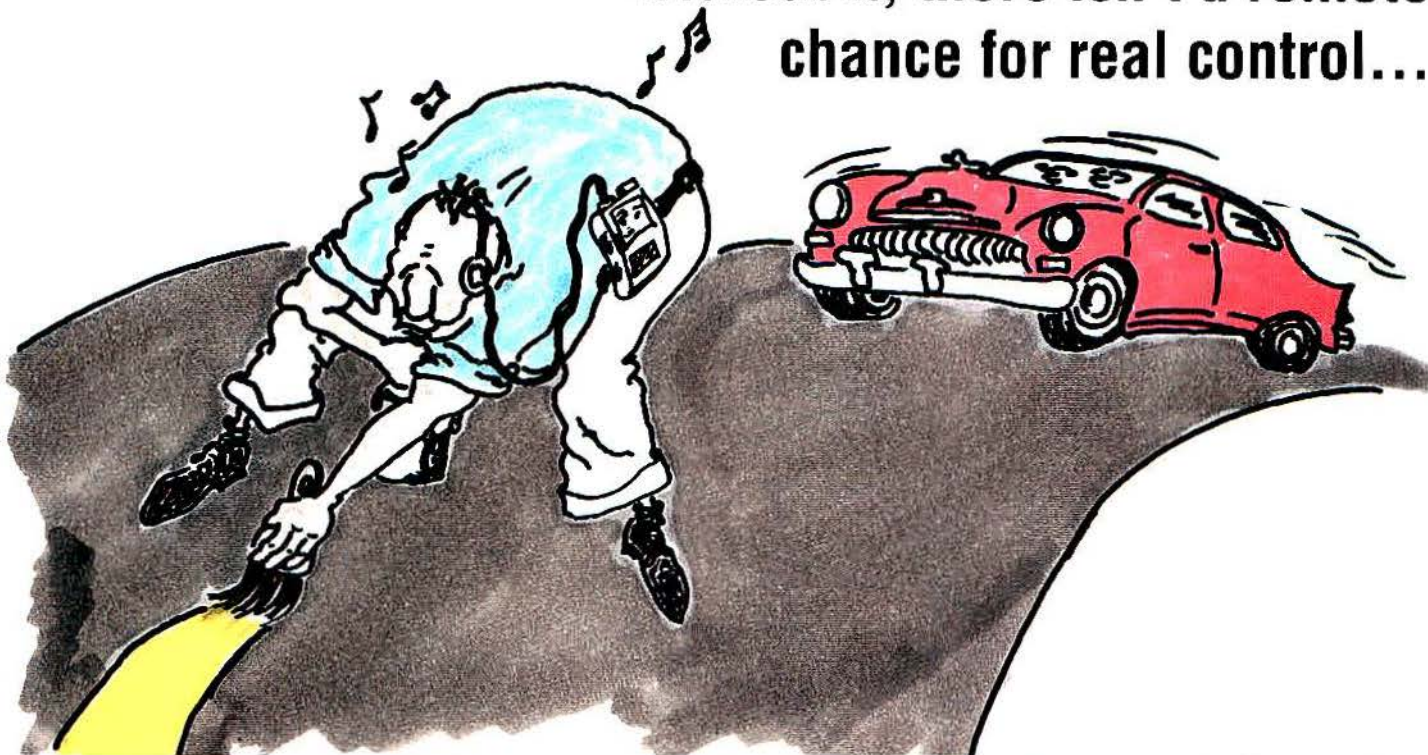
**CELLSMART INC.** • 3100 Skokie Blvd., Highland Park, IL 60035 • Ph. 312/831-1000  
Also available through Tessco, Inc. (800) 638-7666

Circle (60) on Fast Fact Card



# SURVIVAL RELIES ON PROPER SENSORY FEEDBACK

Without it, there isn't a remote chance for real control...



*Beyond the limits of electromechanical relays and open collectors lies the senses of "optically isolated Power I/O Modules"... ingenious devices which control and sense 4 to 240 volts AC or DC.*

Field configured by the end user (factory customization is unnecessary), the **CSI-52 Power I/O Controller** enables up to 24 Power I/O Modules to operate individually as latched outputs or as momentaries, group controlled or interlocked outputs. Modules can be set for alarm inputs, status change inputs or as inputs controlling outputs. Both inputs and outputs can also be set for data accumulation of up to 65,535 activations and up to 65,535 hours of operation.

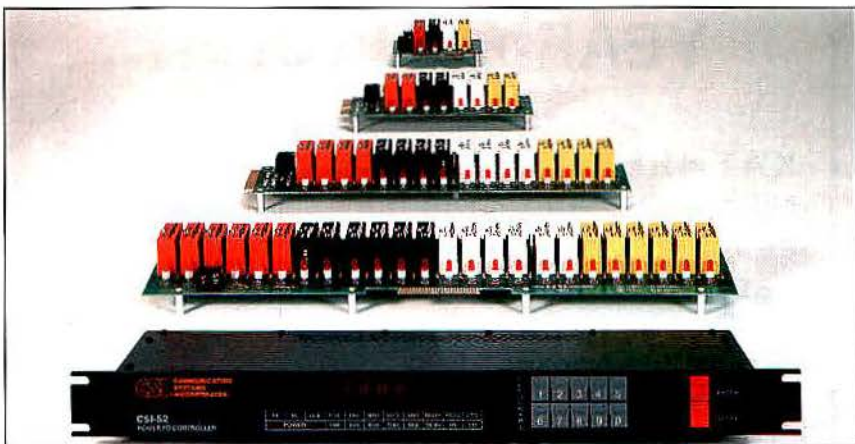
*The CSI-52 can be user configured from the front panel keyboard to address literally thousands of applications...*

*Never* before has the two way radio user had the opportunity for such control and sensing with a DTMF microprocessor based controller... and for no more expense than the cost of a traditional DTMF system. Further convenient, the **CSI-52** will easily interface to any model transceiver and is controllable by radio, telephone, microwave, or leased line.

**Sense the advantages and call us for our brochure and specifications...**

## Introducing the CSI-52 Power I/O Controller

Remote Control • Alarm • Status Reporting  
and Data Accumulation



- Up to 24 Output Modules (AC or DC on/off)
- Up to 24 Input Modules (AC or DC sensing)
- Up to 24 Momentary Output (AC or DC, 1 to 255 seconds)
- Up to 24 Extended Momentary Output (AC or DC, 1 to 255 minutes)
- Up to 24 Interlocked Output Modules (per group, 3 groups maximum)
- Up to 24 Group Controlled Output Modules (per group, 3 groups maximum)
- Up to 200 Event-Programmable Clock for Daily and Weekly Control

**CSI** **COMMUNICATION  
SYSTEMS  
INCORPORATED**

1165 Harrison Street  
Seattle, Washington 98109  
(206) 622-7477  
(800) 222-5570



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# YEAR-ROUND!

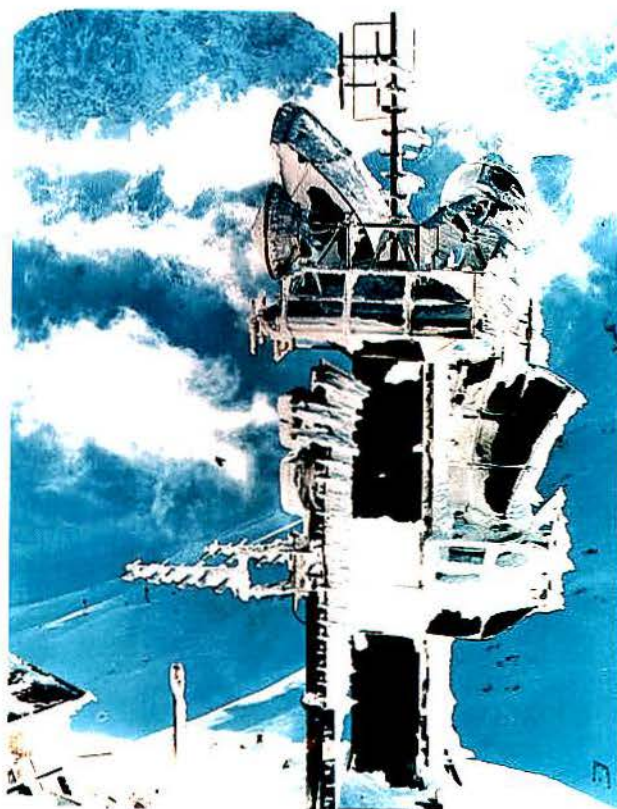
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**You Liked the PK-80? You'll Love the PK-90!**

- Data rates from 1200 baud, dependent on channel bandwidth
- Easy datalink trouble shooting with remote control of PK-90 by radio
- Password access ensures system security
- SMR operation with trunked radio interface
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- Host computer control language
- 12 VDC power allows portable or mobile operation
- Easy connection to your computer and radio
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The PK-90 replaces the PK-80 Packet Radio Controller and brings you the above features NEW TO PACKET. Applications range from remoting a computer terminal through a radio link to control of distant equipment using the PK-90 with inexpensive SCADA controllers. You can coexist on a simplex channel with other voice or data users. Data is error-free, and the untrained user can learn station operation quickly. A station can cost less than \$1000. JUST CALL AND ASK!!

Ask about the PK-232 and PM-1 for SSB data transmission.

**Your imagination is the only limit.** Call John Gates, or circle the reader service number, DEALER INQUIRIES INVITED.

**Advanced Electronic Applications Inc.**

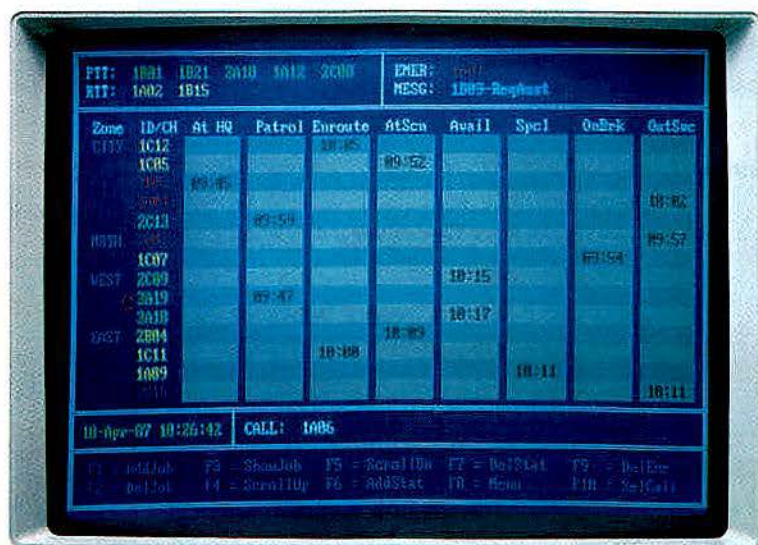
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**Add the Finishing Touch . . .****You Already Own 75% of a Packet Radio Station!**

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The Coded Mobile Radio fleet status and control system brings medium to small fleets into the Computer Aided Dispatch (CAD) picture. This state-of-the-art system is IBM compatible and is a low-cost alternative to high-cost CAD systems. Suitable for both public safety and business applications, the Coded System 1040 offers an integrated software and hardware package for vehicle status and mobile data communications.

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Let Coded put this System 1040 CAD picture in your dispatch operation. Contact Coded Communications for complete information on the high technology and low costs that can put you in the picture.

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Hewlett-Packard  
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Midlan Electronics Inc. .... 46  
Motorola Inc., Communications Sector

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You're closing in on a suspect after months of work. You think you're arriving unannounced, but he's waiting for you. Add the CYCOMM VEM-1000 to your radio system and he won't hear you coming.

The VEM-1000 is the only affordable voice scrambling device on the market that makes it virtually impossible to listen in to your radio conversations.

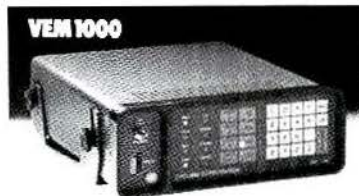
The VEM-1000 is easy to connect to your existing radio, easy to use, and easy to change codes. You can switch to scrambled speech by pressing one button. All your other units will automatically respond.

The VEM-1000 converts voice communication into a scrambled signal with billions of possible code combinations. This same technology allows for unimpaired range and the best voice quality you've ever heard. Just a few of the reasons this equipment is used by the United States Government.

With the VEM-1000 you can communicate with the rest of your team in complete security. Defeat high tech eavesdroppers. Make their equipment worthless.

For more information about the VEM-1000 call or write:  
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Portland, Oregon 97223  
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**800-523-8636**



**CYCOMM**

THE COMMUNICATIONS SECURITY COMPANY

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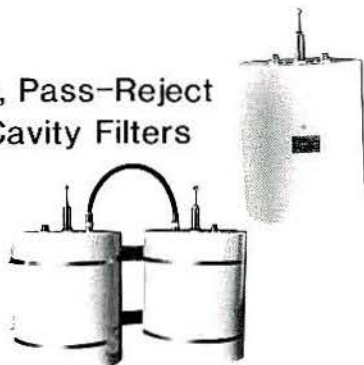
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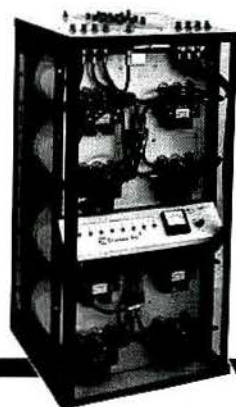
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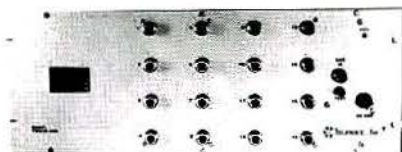
Bandpass, Pass-Reject  
& Notch Cavity Filters



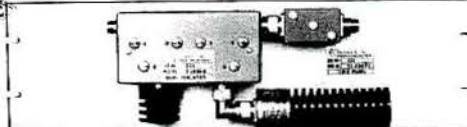
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Receiver Multicoupling



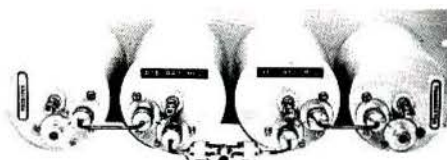
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Richmond, B.C. Canada V7A4S5 (604) 274-8300

TWX 910-379-5055

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# This polymer seal and brass pin are the secret to longer lasting pager batteries.

When the message absolutely must get through, you need pager batteries you can trust. This is why we think you should use the freshest, longest lasting mercury battery on the market. Mercury pager batteries developed and manufactured by Alexander Batteries here in the United States.

## Longer lasting batteries mean happier customers.

At Alexander, we've completely redesigned the mercury battery to put more power in it. Then we built one of the most sophisticated manufacturing facilities in the world . . . right here in the United States. You get higher quality, longer lasting batteries with more power packed into each cell.



Manufactured in the United States, Alexander mercury pager batteries are the freshest on the market.

## Polymer seal and brass current collector are the secret.

In the past, a common problem with mercury batteries was the leaking of white, powdery,

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corrosive electrolyte. This is no longer a problem with the unique, leak-proof polymer seal and brass pin design developed by Alexander. The polymer seal serves as insulation to keep the electrolyte in while keeping harmful contaminants out. The brass pin serves to collect and transport power to the head of the pin and, ultimately, to your pager. The head of the pin is capped with a second barrier. As a result, the electrolyte simply can't leak out.

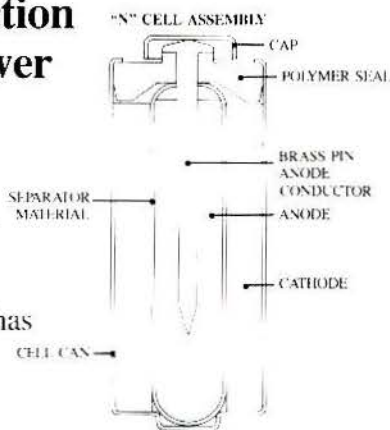
## New separator material lengthens shelf life.

Microcalorimetry, measuring heat output in terms of microcalories, was applied to measure the normal electro-chemical reactions within the cell. Comparisons between separators were then made to determine which separator caused the least amount of self discharge.

As a result of using this technology, Alexander discovered a unique new separator material that creates a self-discharge rate as low as those rates currently acceptable for implantable pacemaker-type cells (10 u watt).

## Unique construction means more power per cell.

The thinner separator, leak-proof polymer seal, brass pin current conductor, and unique design mean Alexander has packed more power into each cell. This means you get longer lasting batteries.



## Each cell tested twice prior to shipment.

In addition to testing all inputs — chemicals and separator — we test each cell as it comes off our automated production line. Then the battery is put into storage for a predetermined length of time that varies by battery type. Each battery is tested again just prior to shipping to make sure it has the power you're paying to receive.

## FREE brochure and catalog.

Find out more about why your Alexander representative is your best source for both rechargeable and disposable pager batteries, call or write for a free catalog and brochure. Our address is: Alexander Manufacturing, P.O. Box 1508, Mason City, IA 50401.



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Pacific Circuit Design Ltd.	

# FERRITRONICS

## MAKING WAVES

*There is only one CTCSS board which is best for your portable.*

### PG18 CTCSS PROGRAMMABLE ENCODER/DECODER

**SPECIFICATIONS:**

Frequency Range	670 Hz to 2503 Hz All 37 EIA CTCSS and 1 non-EIA tone (97.4 Hz)
Voltage Range	8.0 VDC to 16 VDC as supplied 5 VDC min., 35 VDC max. with modifications
Current	10 mA DC @ 10 VDC
Temperature Range	-30°C to +60°C
Size	0.6 inch x 2.0 inch x 0.25 inch 1.52 cm x 5.08 cm x 0.65 cm
Keying	Positive or negative
Output Impedance	1K ohm minimum
Output Level	1.7 Vpp @ all CTCSS frequencies into 51k ohms
Rise Time	20 mSec typical to 90%
Distortion	Less than 5% T.H.D.
Stability	±0.5% as per E.I.A. RS-220A specifications
Signal to Noise	Better than 8 dB Sinad
Input Impedance	100K ohms minimum
Tone Input Level	0.3 Vpp @ 250 Hz, 0.25 Vpp @ 67 Hz, maximum
Decode Time	200 mSec typical, 370 mSec maximum
Bandwidth	2% typical, or as EIA spec. RS-220A
Monitor Function	Ground to squelch, release from ground to unsquelch
Squelch Control	Ground-to-squelch or float-to-squelch
Audio Filter	The audio filter output is only switched on when the unit decodes or the monitor circuit is activated. The attenuation of CTCSS tones is typically 40 dB.
Audio Input Level	1.8 Vpp @ 1kHz, maximum as shipped.



**FERRITRONICS**

Canada  
(416) 884-3180

United States  
(716) 282-7470  
(800) 828-6884



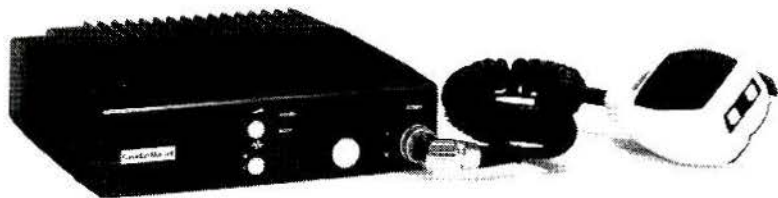
PG-18  
\$53.95

Circle (69) on Fast Fact Card



# At CANADIAN MARCONI COMPANY we have the products you need to give yourself one of the best possible radiotelephone networks

We have medium capacity and high capacity MOBILES:



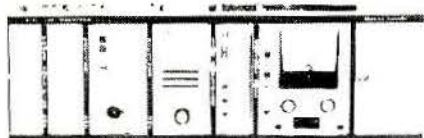
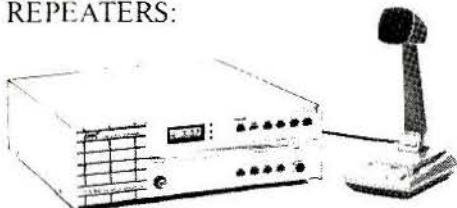
VHF/UHF, 2/16 or up to 198 Channels, 30/40 Watt, CPU controlled, 100% solid state, scan and priority channels, proven performance and reliability record.

We have PORTABLES:



VHF/UHF, 5/1 Watt switchable, 16 Channels with scan and priority, 24 MHz wideband, DTMF.

We have BASE STATIONS and REPEATERS:



VHF/UHF rack or table mount, 5/30/100 Watt, plug-in modules, remote control, CTCSS, continuous duty.

We have RURAL RADIOTELEPHONE LINKS:



VHF/UHF for that out of the way subscriber telephone connection or link to your repeater site, 10 Watt, Single or 1+1 Channels, in-built alarms/monitoring, rack or table mount.

With the above products and our many years of experience in the radiotelephone business, you cannot afford not to contact us:

**CMC**  
CANADIAN MARCONI  
COMPANY

COMMERCIAL COMMUNICATIONS  
DEPARTMENT  
2442 Trenton Avenue  
Montreal, Quebec, Canada H3P 1Y9

TEL: (514) 341-7630  
TLX: 05-827822

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Solid State Communications, Inc.	3
Tait Electronics USA, Inc.	106,143
Tekk Inc.	
Telemobile Inc.	
Tessco	21
Trans Com, Inc.	
Two Comm Inc.	
Uniden	91

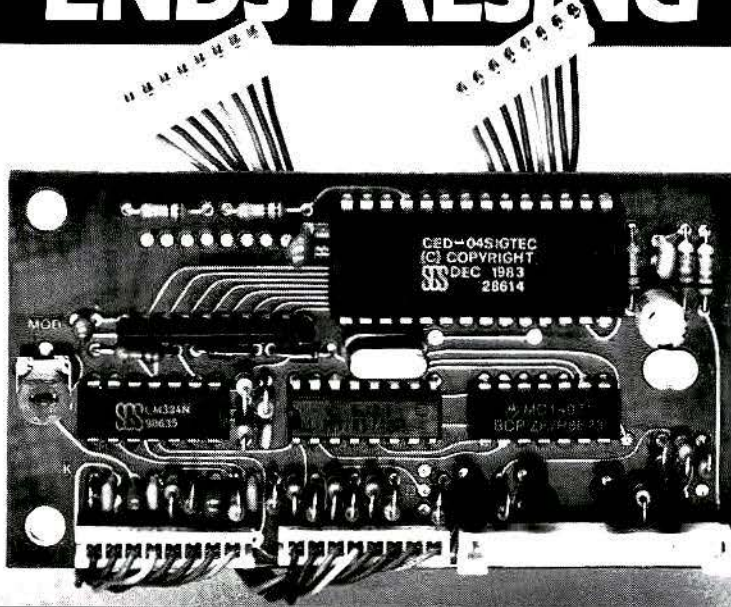
Wisco International Ltd.

**CTCSS Encoders**

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Beam Radio Inc.	58
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Canadian Marconi Co.	71
Cartwright Communications Co.	
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Ceter Vigi	9
Clearstone Telecoms Ltd.	
Communications Associates, Inc.	14

Communications Specialists, Inc.	BC
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Hewlett-Packard	
M. Hutton & Co.	16
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Solid State Communications, Inc.	3
Tait Electronics USA, Inc.	106,143
Tekk Inc.	
Telemobile Inc.	
Tessco	21
Trans Com, Inc.	
Two Comm Inc.	
Uniden	91
Wisco International Ltd.	
Zetron, Inc.	27

# NEW CTCSS ENDS FALSING



## Plug Sigtone's C1109 CTCSS enc/decoder into your Midland mobile and end falsing.

With the Sigtone C1109 you can now offer your clients a superior direct plug-in CTCSS encoder/decoder, especially designed for the Midland Synchro and LMR range of VHF/UHF mobiles.

Due to a unique "square" frequency response over a very wide dynamic range the C1109 allows the use of adjacent tones on the same RF channel - WITHOUT THE RISK OF FALSING.

The C1109 is based on Sigtone's proprietary, well known SI signalling microchips, providing full 37 FIA tones - and the 97.4 Hz.

### Other major features include:

- 1x (busy) lockout for Community Repeater Operation
- Fully programmable through the radio's E-PROM
- Multiple CTCSS tone operation
- Quartz crystal controlled encoding and decoding functions
- Encoder only operation
- Nominal 0dB signal/noise decode sensitivity
- Two-year warranty

Dealer price FOB Sigtone Los Angeles, CA. Qty's: 1-9, \$53.35; 10-24, \$48.00; 25+, \$43.20.

**Contact Sigtone today for details on the C1109.**

# SIGTONE

Sigtone, Inc. Sunset/Vine Tower  
Suite 1126, 6290 Sunset Blvd  
Los Angeles, CA 90028 - 8770  
Tel (213) 463 4474 Fax (213) 463 4319

Sigtone, Inc. specialises in high quality, high performance, tone signalling products for radio communication.

4897SIG

**Digital Decoders**

The Antenna Farm, Inc.	
Beam Radio Inc.	58
California Radio	
Cartwright Communications Co.	
Clearstone Telecoms Ltd.	
Coded Communications Corp.	65
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**Digital Encoders**

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Beam Radio Inc.	58
Birham Industries Inc., Orbacom	
Div.	38
California Radio	
Cartwright Communications Co.	
CES-Communications Electronics	
Specialties, Inc.	11
Clearstone Telecoms Ltd.	
Coded Communications Corp.	65
Communications Associates, Inc.	14
Communications Products Inc.	



# IN-STOCK FOR IMMEDIATE SHIPPING

## Bird™ Wattmeter

For your convenience, we maintain a large inventory of Bird Wattmeters, elements, loads, and accessories for immediate delivery.

Contact us for all your Bird equipment needs.



## RF Power Amplifiers

We've got RF Amplifiers in-stock. Delivery when you need it. Guaranteed to specs, year after year. We've got our dependable reputation behind these products and offer them at realistic prices. You can count on Henry Radio!



## Data Communications

Why spend money on phoneline rental and modems when you can send any alphanumeric information via your existing radio?

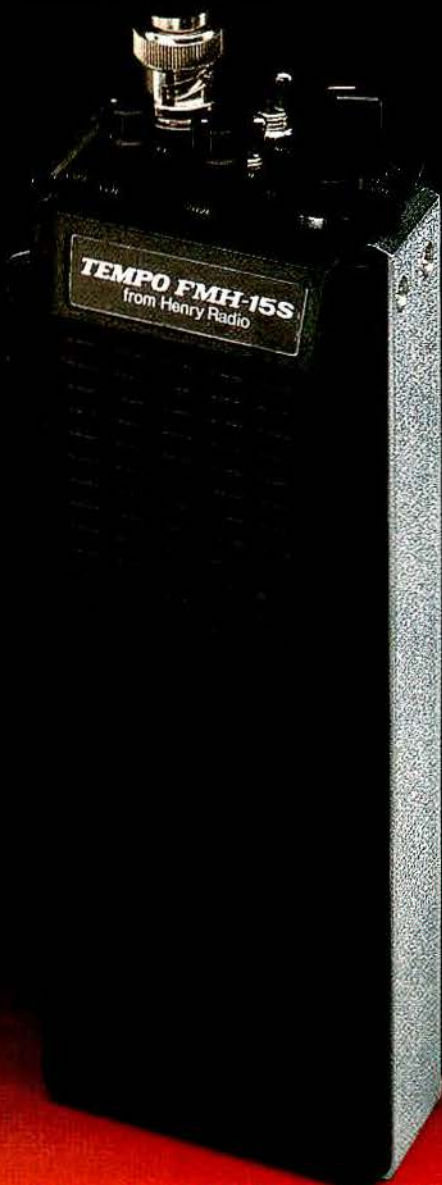
Applications in security, police, medical emergency, water department, highway department and many more. Your imagination is the only limit.



## Tempo™ Hand-Held Radios *Full line of accessories.*

Versatile, dependable local communications! Tempo FM business band portables save time and money in providing local communications. Eliminate errors, speed deliveries and improve productivity with instant person-to-person communications.

Perfect for security, construction, agribusiness, warehousing, marine operations, ski patrol, airlines, fire and police and hundreds of other applications.



# HENRY RADIO

*Over a half-century of reliability in communications.*

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Also in stock: ASTRON Power Supplies, CUSHCRAFT Antennas, LARSEN Antennas, MAXCOM Antenna Tuners, PIPO Touchtone Pads, MAG INSTRUMENTS Flashlights plus much more two-way and amateur radio equipment and supplies.

Circle (72) on Fast Fact Card



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Ferritronics Inc. .... 70	ECD ..... 110	Beam Radio Inc. .... 38
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Motorola Inc., Communications Sector	Midian Electronics Inc. .... 46	Specialties, Inc. .... 11
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Regency Electronics	Palamor Engineers	Communications Associates, Inc. .... 14
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Cartwright Communications Co.	Telemobile Inc.	Meridian Communications, Inc.
Cellular Communications Corp.	Tessco ..... 21	Midian Electronics Inc. .... 46
Cetec Vega ..... 9	Trans Com, Inc.	Modular Communications Systems,
Clearstone Telecoms Ltd.	Two Comm Inc.	(Moducom)
Communications Associates, Inc. .... 14	Uندن ..... 91	Motorola Inc., Communications Sector
Communications Products Inc.	Wisco International Ltd.	Norcomm Corp. .... 22
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Connect Systems Inc. .... 19,78	The Antenna Farm, Inc.	Penta Corp.

Company Addresses begin on page 90

## ACCURACY DIGIMAX PERFORMANCE



10 MHz Oven Oscillator 9 X 8 1/2 X 3 1/4  
10 Hz to 1.2 GHz .1 PPM ACCURACY



50 Hz to 512 MHz 5 1/4 X 5 X 1 1/2  
1 PPM ACCURACY  
TCXO

ALL MODELS HAVE 1 YEAR WARRANTY

Optional factory installed rechargeable battery pack available

### DIGIMAX INSTRUMENTS CORP.

MODEL	PRICE	FREQUENCY RANGE	ACCURACY OVER TEMPERATURE	READ OUTS	SENSITIVITY TYP.		POWER REQ.
					50 Hz-25 MHz	25 MHz-450 MHz	
D500	\$149.95	50 Hz-512 MHz	1 PPM 17°-35°C TCXO	8	15 to 50 MV	20 to 50 MV to 450 MHz	8-15 VDC 300 MA
D510	\$179.95	50 Hz-1.0 GHz	TIME BASE			50 to 100 MV to 1 GHz	AC-12 REQ. FOR
D612	\$259.95	50 Hz-1.2 GHz	0.1 PPM 20°-40°C PROPORTIONAL	9	15 to 50 MV	15 to 50 MV to 450 MHz	110 VAC 8-15 VDC
D1200	\$299.95	10 Hz-1.2 GHz	10 MHz OVEN		15 to 50 MV	20 to 100 MV to 1 GHz	500 MA

AC-12 AC-ADAPTER \$8.95

T-1200 BNC-BASE 21" ANT. \$8.95

BAC12 \$34.95 BAC5 \$29.95

FOR DEALER LOCATIONS  
OR PHONE ORDERS  
800-854-1566  
8560 Production Ave.  
San Diego, CA 92121  
California Call 619-578-7171  
Telex #697120-DATAMAX-103

EXPORT AGENT: MAGNUS  
3500 Devon Avenue  
Chicago, IL 60659  
312-679-6070  
Telex #253503 MAGNUS CGO

Circle (73) on Fast Fact Card





MODEL VS-50M

### RS, RM and VS SERIES

#### SPECIAL FEATURES

- SOLID STATE ELECTRONICALLY REGULATED
- FOLD-BACK CURRENT LIMITING Protects Power Supply from excessive current & continuous shorted output.
- CROWBAR OVER VOLTAGE PROTECTION on all Models except RS-4A, RS-5A.
- MAINTAIN REGULATION & LOW RIPPLE at low line input Voltage.
- HEAVY DUTY HEAT SINK • CHASSIS MOUNT FUSE

- HEAVY DUTY • HIGH QUALITY • RUGGED • RELIABLE •

- THREE CONDUCTOR POWER CORD
- ONE YEAR WARRANTY • MADE IN U.S.A.

#### PERFORMANCE SPECIFICATIONS

- INPUT VOLTAGE: 105 - 125 VAC
- OUTPUT VOLTAGE: 13.8 VDC  $\pm$  0.05 volts (Internally Adjustable: 11-15 VDC)
- RIPPLE: Less than 5mv peak to peak (full load & low line)
- Also available with 220 VAC Input Voltage

### RM-A SERIES



MODEL RM-35M

### 19" X 5 1/4" RACK MOUNT POWER SUPPLIES

MODEL	Continuous Duty (Amps)	ICS* (Amps)	Size (IN) H x W x D	Shipping Wt. (lbs.)
RM-12A	9	12	5 1/4 x 19 x 8 1/4	16
RM-35A	25	35	5 1/4 x 19 x 12 1/2	38
RM-50A	37	50	5 1/4 x 19 x 12 1/2	50

#### • Separate Volt and Amp Meters

RM-35M	25	35	5 1/4 x 19 x 12 1/2	38
RM-50M	37	50	5 1/4 x 19 x 12 1/2	50

### RS-A SERIES



MODEL RS-7A

RS-4A	3	4	3 3/4 x 6 1/2 x 9	5
RS-5A	4	5	3 1/2 x 6 1/8 x 7 1/4	7
RS-7A	5	7	3 3/4 x 6 1/2 x 9	9
RS-10A	7.5	10	4 x 7 1/2 x 10 3/4	11
RS-12A	9	12	4 1/2 x 8 x 9	13
RS-20A	16	20	5 x 9 x 10 1/2	18
RS-35A	25	35	5 x 11 x 11	27
RS-50A	37	50	6 x 13 3/4 x 11	46

### RS-M SERIES



MODEL RS-35M

#### • Switchable volt and Amp meter

RS-12M	9	12	4 1/2 x 8 x 9	13
--------	---	----	---------------	----

#### • Separate volt Amp meters

RS-20M	16	20	5 x 9 x 10 1/2	18
RS-35M	25	35	5 x 11 x 11	27
RS-50M	37	50	6 x 13 3/4 x 11	46

### VRM/VS-M SERIES



MODEL VS-35M

#### • Separate Volt and Amp Meters • Output Voltage adjustable from 2-15 volts

#### • Current limit adjustable from 1.5 amps to Full Load

	@ 13.8VDC or 10VDC @ 5VDC	@ 13.8V		
VS-20M	16	9	4	20
VS-35M	25	15	7	35
VS-50M	37	22	10	50

#### • Variable rack mount power supplies

VRM-35M	25	15	7	35	5 1/4 x 19 x 12 1/2	38
VRM-50M	37	22	10	50	5 1/4 x 19 x 12 1/2	50

\*ICS—Intermittent Communication Service (50% Duty Cycle 5 min. on 5 min. off)

## DC-DC CONVERTERS



MODEL 1212



MODEL 1212-18

### MODEL 1212 & 1212-18 Switching Regulated Converter.

Designed for FM transceivers and other applications requiring 12 volt power source converted from 12 volt positive ground battery. Regulation with pulse width modulation at 20 KHz. Input—12V DC (Positive ground only). Functional from —11 V DC to—16 V DC. Output +13.8 V DC (Negative ground only).

	1212	1212-18
Output Voltage	13.8 V DC $\pm$ 2 V DC	13.8 V DC $\pm$ 2 V DC
Line/Load Regulation	200 mV	200 mV
Ripple/Noise	50 mV RMS	50 mV RMS
Current Continuous	6 Amp	14 Amp
Current (ICS)	9 Amp	18 Amp
Current Limit	12 Amp	19 Amp
Case	2 3/4" (H) x 6" (W) x 6" (D)	2 3/4" x 6" x 12"
Shipping Weight	2 lbs.	4 lbs.



MODEL 2412



MODEL 2412-16

### MODEL 2412 & 2412-16 Switching Regulated Converter.

Designed for FM transceivers and other applications requiring 12 volt power source converted from 24 volt battery. Regulation with pulse width modulation at 20 KHz. Input +28 V DC (Negative ground only). Functional from +22 V DC to +32 V DC. Output +13.8 V DC (Negative ground only).

	2412	2412-16
Output Voltage	13.8 V DC $\pm$ 2 V DC	13.8 V DC $\pm$ 2 V DC
Line/Load Regulation	200 mV	200 mV
Ripple/Noise	50 mV RMS	50 mV RMS
Current Continuous	9 Amp	16 Amp
Current Limit	12 Amp	20 Amp
Case	2 3/4" (H) x 6" (W) x 6" (D)	2 3/4" x 6" x 12"
Shipping Weight	2 lbs.	4 lbs.

ALSO! AVAILABLE AS MODEL 3612 & 3612-16: +36 V DC (Negative ground only) AND AS MODEL 4812 & 4812-16: +48 V DC (Negative ground only).



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Zetron, Inc.	27

## Multitone Decoders

The Antenna Farm, Inc.	
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Cetec Vega	9
Clearstone Telecoms Ltd.	
Communications Associates, Inc.	14
Communications Specialists, Inc.	BC
Electronic Products Inc.	
Ferritronics Inc.	70
M. Hutton & Co.	16
Kenwood USA Corp.	7
Meridian Communications, Inc.	
Midian Electronics Inc.	46

Motorola Inc., Communications Sector	
Norcomm Corp.	22
Pacific Circuit Design Ltd.	
Penta Corp.	
Raven Electronics Corp.	
Regency Electronics	
Secom Systems	
Selectone Corp.	1
Sigtec Pty. Ltd.	
Sigtone Inc.	72
Tessco	21
Two Comm Inc.	
Wisco International Ltd.	
Zetron, Inc.	27

## Multitone Encoders

The Antenna Farm, Inc.	
Beam Radio Inc.	58
Birham Industries Inc., Orbacom	
Div	38
Canadian Marconi Co.	71
CES-Communications Electronics	
Specialties, Inc.	11
Cetec Vega	9
Clearstone Telecoms Ltd.	
Communications Associates, Inc.	14
Communications Specialists, Inc.	BC
Connect Systems Inc.	19,78
Electronic Products Inc.	
Ferritronics Inc.	70
Hewlett-Packard	
M. Hutton & Co.	16
Kenwood USA Corp.	7

Meridian Communications, Inc.	
Midian Electronics Inc.	46
Modular Communications Systems	
Motorola Inc., Communications Sector	
Norcomm Corp.	22
Pacific Circuit Design Ltd.	
Penta Corp.	
Raven Electronics Corp.	
Regency Electronics	
Secom Systems	
Selectone Corp.	1
Sigtec Pty. Ltd.	
Sigtone Inc.	72
Tessco	21
Two Comm Inc.	
Wisco International Ltd.	
Zetron, Inc.	27

## Single-tone Decoders

The Antenna Farm, Inc.	
Avtec Inc.	
Beam Radio Inc.	58
Bramco Inc.	
Canadian Marconi Co.	71
Cartwright Communications Co.	
Cetec Vega	9
Clearstone Telecoms Ltd.	
Communications Associates, Inc.	14
Data Signal, Inc.	118,119
Electronic Products Inc.	
Ferritronics Inc.	70
M. Hutton & Co.	16
Meridian Communications, Inc.	

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GENUINE  
FULL GRAIN  
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RADIOS • PAGERS  
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of your trade-  
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25 cases or  
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variety of coloursProtect your investment of a portable  
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## WHY PAINT IT? STROBE IT!

Did you know that the FAA modified their tower painting and lighting specifications to permit tower owners to delete painting and red lights on 200'-500' towers by installing white strobe beacons?

**BROADCAST COMMUNICATIONS** has fulfilled its contract with the Wisconsin Bureau of Aeronautics and **now makes available to you**, what we believe to be, the most reliable tower strobe beacon ever developed.

## MODELS INCLUDE:

"RETROFIT" — Installs into existing 300mm code beacon

"SHORTY" — Used for new towers and reduction in wind load

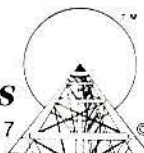
DUAL LIGHTING — One housing for strobe/day and red/night

ALARM PANEL — Audible alert and remote alarm



## Brighter Idea, STROBES

Please contact us for information and literature.

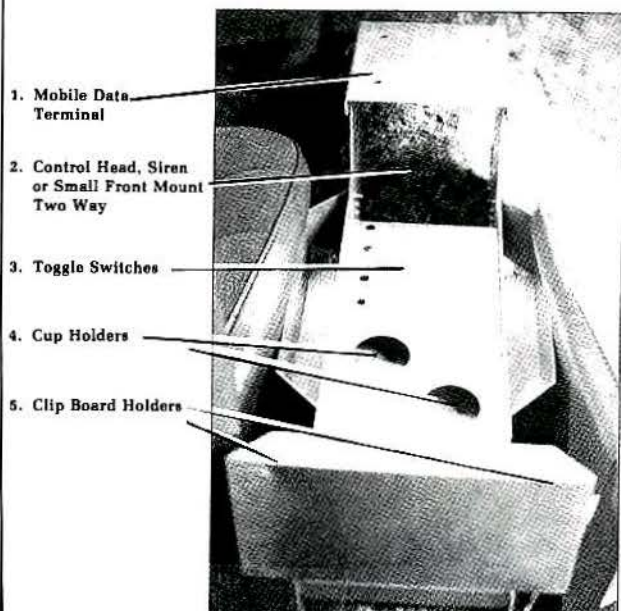
**Broadcast Communications**6 Round Hill Circle Madison, WI 53717  
608/833-3977

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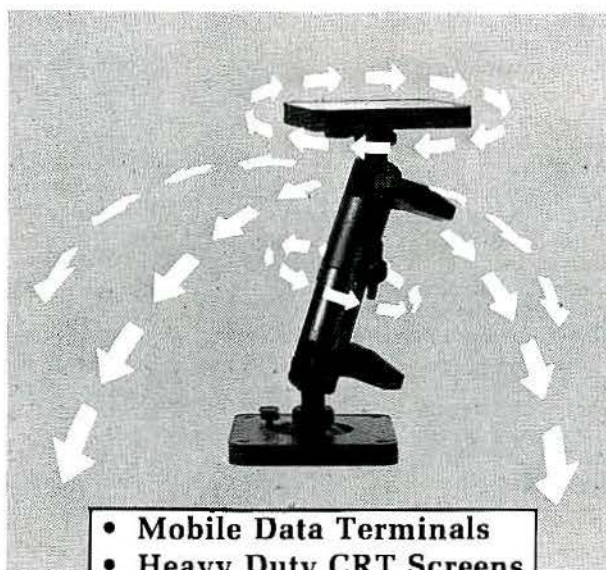


# We've Eliminated The "How & Where" In Mounting Almost Anything

## Vehicle Communications Control Console



## Heavy Duty Swivel Mount

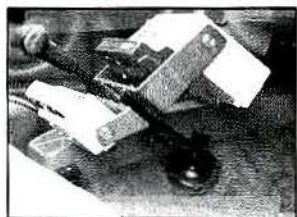


- Mobile Data Terminals
- Heavy Duty CRT Screens
- CCTV Cameras
- Two Way Radios

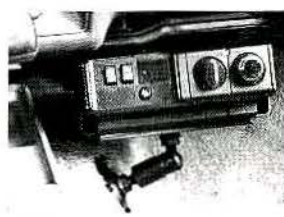
New

### TWO WAY RADIO

Mount a two way radio, scanner or siren along with a control head, or mount multi control heads as pictured—mount data terminals, DTMF Pads. Pre-made and blank plates available.



Why Fret about Plastic Dashboards. SMC Makes Installing Easy. It Even Doubles as a Slide Mount with Quick Release.



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Norcomm Corp.	22	Hewlett-Packard		Electronic Products Inc.	
Raven Electronics Corp.		M. Hutton & Co.	16	M. Hutton & Co.	16
Reach Electronics, Inc.		Meridian Communications, Inc.		Kenwood USA Corp.	
Regency Electronics		Midian Electronics Inc.	46	Lesmith Ltd.	113
Repco Inc.	39	Modular Communications Systems, (Moducom)		Lucas Industries Inc.	
Secom Systems		Motorola Inc., Communications Sector		Meridian Communications, Inc.	
Selectone Corp.	1	Norcomm Corp.	22	Midian Electronics Inc.	46
Sigtone Inc.	72	Raven Electronics Corp.		Motorola Inc., Communications Sector	
Solid State Communications, Inc.	3	Raven Radio Mfg., Inc.	53	Norcomm Corp.	22
Telemobile Inc.		Reach Electronics, Inc.		Pacific Circuit Design Ltd.	
Tessco	21	Regency Electronics		Raven Radio Mfg., Inc.	53
Trans Com, Inc.		Repco Inc.	39	Reach Electronics, Inc.	
Two Comm Inc.		Secom Systems		Regency Electronics	
Wisco International Ltd.		Selectone Corp.	1	Repco Inc.	39
		Solid State Communications, Inc.	3	Secom Systems	
<b>Single-tone Encoders</b>		Telemobile Inc.		Selectone Corp.	1
The Antenna Farm, Inc.		Tessco	21	Solid State Communications, Inc.	3
Avttec Inc.		Two Comm Inc.		Telemobile Inc.	
Beam Radio Inc.	58	Wisco International Ltd.		Tessco	21
Birham Industries Inc., Orbacom Div.	38	Zetron, Inc.	27	Trans Com, Inc.	
Bramco Inc.				Two Comm Inc.	
Canadian Marconi Co.	71	<b>Two-tone Sequential Decoders</b>		Uniden	91
Cartwright Communications Co.		The Antenna Farm, Inc.		Wisco International Ltd.	
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Cleartone Telecoms Ltd.		Bramco Inc.		The Antenna Farm, Inc.	
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Data Signal, Inc.	118,119	Cetec Vega	9	Birham Industries Inc., Orbacom Div.	38
		Cleartone Telecoms Ltd.		Bramco Inc.	
		Communications Associates, Inc.	14		



# Newest Technology, Oldest Reliability

## A totally new concept in multichannel logging recording.

### 100% Electronic and Mechanical Back Up Reliability.

Each Record/Playback deck has everything needed to maintain continuous recording. Unlike competitive models, record/reproduce and control electronics **plus** time code generator reader and automatic search are **standard** in each deck.

### Complete Microprocessor Control.

No more guess work! Time Code, Fail Safe, and programmable transfer time are standard. In the unlikely event of failure(s) the advanced digital display Fail Safe system shows you precise channel failure.

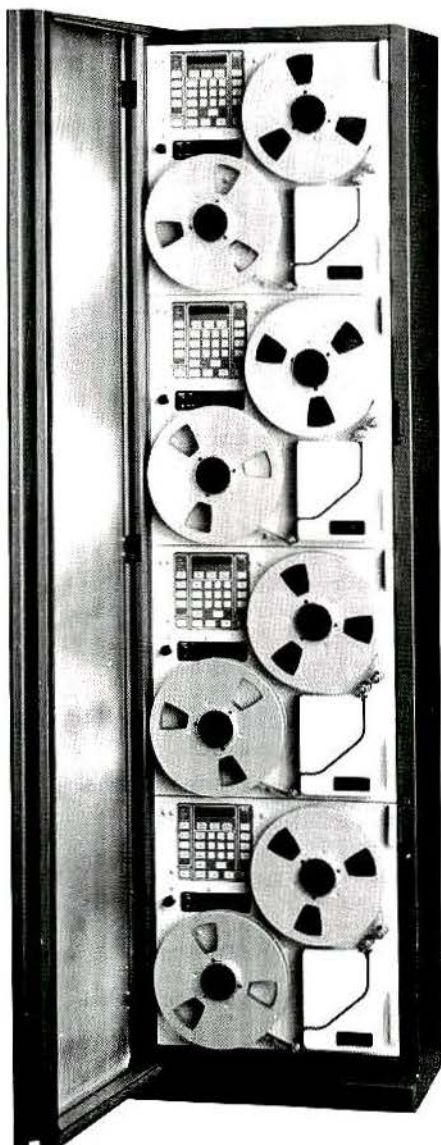
### Central Processing Unit (CPU) Diagnostics.

Not only does the control diagnostics test tell when there is a problem, it tells where the problem is within the control unit.

### Tape and Head Wear Dramatically Reduced.

Improvements in tape handling and head contour significantly increase tape and head life. Head replacement in 5 minutes — the fastest and easiest available. Three year head warranty is **standard**.

**For 60 years Magnasync/Moviola has monitored product performance.** We use lab and field tests to check operation and durability. These tests are designed to keep up to date with communications needs to give you the newest technology with our proven reliability.



The **SPECIALIST™** is the latest in a series of computer-controlled recording systems. Each deck offers up to 60 record/reproduce channels (options of 10, 20, 30, 40, and 60 channels). Used alone, each deck can be operated in a transportable desk-top cabinet. With 4 record/playback decks housed in a single cabinet, up to 240 channels can be available (as shown).

### The Best Auto Search You Can Buy!

**SPECIALIST™** can find your message in half the time. The automatic search goes directly to your message and plays it. You no longer have to wait for the tape to sweep back and forth passing the message many times before stopping. The Auto Search is **standard** with every record/reproduce or reproduce only decks.

### Easy Maintenance, Less

**Down Time.** All components are accessible from the front — you don't have to move the machine or go behind for maintenance.

### Fast and Easy System Expansion.

No need to return your **SPECIALIST™** to add channels. Add channels yourself or our service personnel will be glad to come do it for you.

### More Channels in Less Space.

You can have 40 record and reproduce channels with a back up system in half the space of competitive models. Or you can have 80 channels with back up in the same amount of space as that of competitive models with 40 channels.

**For additional information on the SPECIALIST™ fill in the coupon or call us.**

Name

Organization

Address

City/State/Zip

Telephone (  )  Ext.

Mail to: Magnasync/Moviola Corporation  
5539 Riverton Avenue  
North Hollywood, CA 91601  
818/763-8441  
Telex: 67-3199 MAGNA/MOVIO LSA

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**moviola**

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Cartwright Communications Co.	<b>Amplitude Companded Single-Sideband (ACSSB)</b>	Aerotron Inc.
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		SEA, Inc.
		Secom Systems
		Spectrum Communications Corp. .... 135
		Standard Communications Corp. .... 81
		Syntec Communications Systems
		Tait Electronics USA, Inc. .... 106,143



**Now Available In 800 MHz**

# Worth The Wait

**Standard's new HX400 continues an award-winning tradition in microprocessor-controlled handhelds**

The digital portable you've been considering is now obsolete.

Because our new HX400 has something no other portable can offer — the engineering experience of Standard Communications.

Not to boast, but since 1983 our HX200 Horizon Hand-Phone has become the world's largest-selling marine portable, one which has garnered an award for design and engineering excellence from the National Marine Electronics Association.

This commitment to excellence, as well as the same microprocessor control technology we put into our marine radios and satellite receivers, is the heart of the HX400. While not the first microprocessor handheld on the market, we've designed it to be the best.

Features include 25 channels and 5-watt power output in both UHF and VHF models. A host of microprocessor controlled functions include one-touch channel selection, priority channel with dual watch capability that continues to monitor your priority channel, 2-to 25-channel programmable scan with memory, and a backlit high visibility liquid crystal digital display.

Channel congestion and "doubling" can be controlled by a "busy" channel lockout feature which prohibits transmission on occupied channels, alerting the operator by tone and symbol on the HX400's digital display. And programming and channel selection controls can be locked out to prevent accidental change.

The HX400 packs all these features into a rugged 28-ounce chassis that includes a twist-off, rechargeable battery pack.

The HX400 has been worth the wait, but wait no longer.



Channel number and microprocessor function are displayed on the HX400's easy-to-read LCD information center. Pushbutton controls for all functions are right where you can see them, making the HX400 simple to use.

Contact your nearest authorized Standard Communications Sales and Service Center or:

**Standard  
Communications**

P.O. Box 92151  
Los Angeles, CA 90009-2151  
Toll free 800/257-1357  
(In Calif. 800/824-7766, ext. 227)

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Circle (81) on Fast Fact Card



Telemobile Inc.	
Teletec Corp.	40-41
Uniden	91
Wisco International Ltd.	

**Base Station Repeaters 406-512MHz**

Air Comm	
Beam Radio Inc.	58
Erie Electronics, Inc.	92
Parkinson Electronics Co.	137
Primus Electronics Corp.	128
Repro Inc.	39
Ritron Inc.	
Spectrum Communications Corp.	135
Standard Communications Corp.	81
Tait Electronics USA, Inc.	106,143
Uniden	91

**Base Station Repeaters 806-940MHz**

AAT Communications Corp.	
Aerotron Inc.	
AmeriCom Corp.	
The Antenna Farm, Inc.	
Beam Radio Inc.	58
The Communications Center	
D&R Associates, Inc.	
Gregory Electronics Corp.	
Hawa Systems USA Inc.	43
E.F. Johnson	
Meridian Communications, Inc.	
Midland Land Mobile Radio	24-25
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Motorola Inc., Communications Sector	
Quintron Corp.	
Standard Communications Corp.	81
Syntec Communications Systems	
Tait Electronics USA, Inc.	106,143
Two Comm Inc.	
Uniden	91
Wisco International Ltd.	

**Base Station Transceivers 25-50MHz**

AAT Communications Corp.	
Aerotron Inc.	
Air Comm	
The Antenna Farm, Inc.	
Beam Radio Inc.	58
California Radio	
Celltronics	
Trilectic/Neulink/Neutec	86
Cobra/Dynascan	59
The Communications Center	
D&R Associates, Inc.	
Erie Electronics, Inc.	92
Glenayre Electronics	
Gregory Electronics Corp.	
Hawa Systems USA Inc.	43
M. Hutton & Co.	16
E.F. Johnson	
LeBlanc & Royle Telcom Inc.	
Meridian Communications, Inc.	
Motorola Inc., Communications Sector	
Primus Electronics Corp.	128
Regency Electronics	
Sonar Corp.	
Standard Communications Corp.	81
Syntec Communications Systems	
TAD USA	
Tait Electronics USA, Inc.	106,143
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Uniden	91
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**Base Station Transceivers 66-88MHz**

AAT Communications Corp.	
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Beam Radio Inc.	58
Celltronics	
Trilectic/Neulink/Neutec	86
Clearstone Telecoms Ltd.	
The Communications Center	
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Gregory Electronics Corp.	
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M. Hutton & Co.	16
E.F. Johnson	
Midland Land Mobile Radio	24-25
Motorola Inc., Communications Sector	
Regency Electronics	
Spectrum Communications Corp.	135
Syntec Communications Systems	
TAD USA	
Tait Electronics USA, Inc.	106,143
Telemobile Inc.	
Wisco International Ltd.	

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AAT Communications Corp.	
Aerotron Inc.	
Air Comm	
Beam Radio Inc.	58
Bendix/King	
California Radio	
Canadian Marconi Co.	71
Celltronics	
Trilectic/Neulink/Neutec	86
Clearstone Telecoms Ltd.	
Communications Associates, Inc.	14
The Communications Center	
Dixcom, Inc.	111
D&R Associates, Inc.	
Electronic Products Inc.	
Erie Electronics, Inc.	92
Glenayre Electronics	
Gregory Electronics Corp.	
Hawa Systems USA Inc.	43
M. Hutton & Co.	16
E.F. Johnson	
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Telemobile Inc.	
Teletec Corp.	40-41
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Wisco International Ltd.	

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The Communications Center	
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Gregory Electronics Corp.	
Hawa Systems USA Inc.	43
M. Hutton & Co.	16
E.F. Johnson	
LeBlanc & Royle Telcom Inc.	
Meridian Communications, Inc.	
Midland Land Mobile Radio	24-25
Motorola Inc., Communications Sector	
NCG Companies	
Plexsys Corp.	
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Regency Electronics	
Syntec Communications Systems	
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AAT Communications Corp.	
Aerotron Inc.	
Beam Radio Inc.	58
Canadian Marconi Co.	71
Celltronics	
Trilectic/Neulink/Neutec	86
D&R Associates, Inc.	
Electronic Products Inc.	
Gregory Electronics Corp.	
Hawa Systems USA Inc.	43
M. Hutton & Co.	16
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AAT Communications Corp.	
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Gregory Electronics Corp.	
Hawa Systems USA Inc.	43
M. Hutton & Co.	16
LeBlanc & Royle Telcom Inc.	
Meridian Communications, Inc.	
Milcom International Inc.	126
Motorola Inc., Communications Sector	





# No drift. No droop. No errors. No matter what you test.

The new 2500C from Wavetek is the first communications test generator to offer flawless FSK modulation for every digital paging and binary coded squelch format on the market. With no code distortions. No carrier drift. To full manufacturer's specifications.

And with a simple elegance that is truly unique to this advanced, 1 GHz signal generator.

## **The challenge of digital coding.**

Until now, testing digital paging equipment with a signal generator meant putting up with one of two flaws.

ACFM generators caused code waveforms to "droop", so that test results would never be repeatable. DCFM generators suffered from frequency drift of several KHz.

## **The digital FSK alternative.**

The new 2500C modulation system—a unique hybrid of digital and analog technology—actually shifts carrier frequency in response to coding inputs. Frequency shift is synthesizer-stable at all times, eliminating drift in data rates from 0 to 20 kilobaud.

Now you can accurately test POCSAG, NEC/D3, GSC(1). And DPL. Even formats that haven't been invented yet.

## **Quick, quiet and friendly.**

The 2500C is so simple to operate, you can sit down and start testing without ever reading the manual.

RFI is low enough to let you test the most sensitive radio pagers made.

Automatic Return to Center

(RTC) frequency allows you to move from digital to analog testing without touching a button.

You can even use analog FM and FSK modes simultaneously with the 2500C.

## **Find out more.**

The 2500C signals Wavetek's fifteen-year-long commitment to the mobile radio testing industry. We're in business to make your job easier, and the 2500C embodies that philosophy.

Learn more about the signal generator you've been waiting for. Call 317-788-5965 for your free brochure. Or write Wavetek RF Products, Inc., 5808 Churchman Bypass, Indianapolis, Indiana, 46203-6109.

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**WAVETEK®**



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Repcor Inc. .... 39	D&R Associates, Inc.	Ritron Inc.



# OUR COMPLEMENTS TO YOUR RADIO

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Syntec Communications Systems  
TAD USA  
Telemobile Inc.  
Wisco International Ltd.

## Portable Transceivers 148-174MHz

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Bendix/King	
California Radio	
Canadian Marconi Co.	71
Celltronics	
Triletric/Neulink/Neutec	86
Clearstone Telecoms Ltd.	
Communications Associates, Inc.	14
The Communications Center	
Dixcom, Inc.	111
D&R Associates, Inc.	
Eric Electronics, Inc.	92
Fujitsu Ten Corp. of America	63
Gregory Electronics Corp.	
Hawa Systems USA Inc.	43
Henry Radio	73
M. Hutton & Co.	16
ICOM America, Inc.	15
E.F. Johnson	
Kenwood USA Corp.	7
Land Mobile Services West	
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## Portable Transceivers 406-512MHz

AAT Communications Corp.	
Aerotron Inc.	
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Arpeda Corp.	
Beam Radio Inc.	58
California Radio	
Canadian Marconi Co.	71
Celltronics	
Triletric/Neulink/Neutec	86
Clearstone Telecoms Ltd.	
Communications Associates, Inc.	14
The Communications Center	
Dixcom, Inc.	111
D&R Associates, Inc.	



OUR complete line of accessories enables use of portable or mobile radios in virtually any situation. We have extensive experience in solving communication problems — from the routine to the extremely difficult... and it's all available to you. Simply contact us.

SOUND IDEAS FROM  
**Setcom**  
CORPORATION

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Mountain View, CA 94043  
415/965-8020

Circle (86) on Fast Fact Card

## PATENTED CELLULAR INTERFACE

**Accepts Standard RJ11 Telephones & Accessories**  
Both Mechanical & Electronic Ringer Telephones, most Payphones, Credit Card Phones, High Speed Burst Auto-Dialers, Burglar/Fire Alarms, High Speed Modems, Slow Scan Video, FAX, Data Telemetry Devices, Voice & Data, Scrambling or Encryption Devices, & Credit Card Approval Units, Status, Control & Data Monitoring Systems

**Adapts to Most Make & Model Transceivers**  
All Amps Compatible, Audiovox CMT400, G.E. "Star", G.E. "Car Phone", Mobira, Motorola Series, NEC, Novatel & Oki CDL.

**Simulates Telephone Central Office**

Tip & Ring Voltage, & Valid Number Recognition, Automatic Send/End Commands To Transceivers, etc.

**Last Number Redial Incoming Call Signal**

**Solid State CMOS Control**

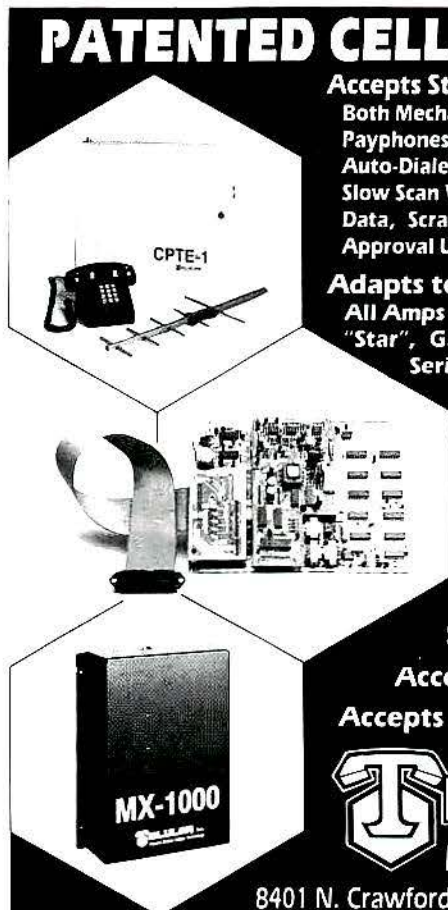
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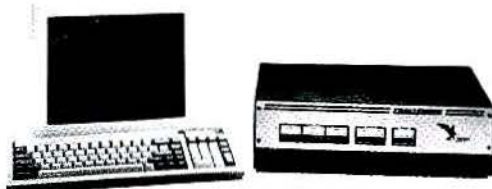
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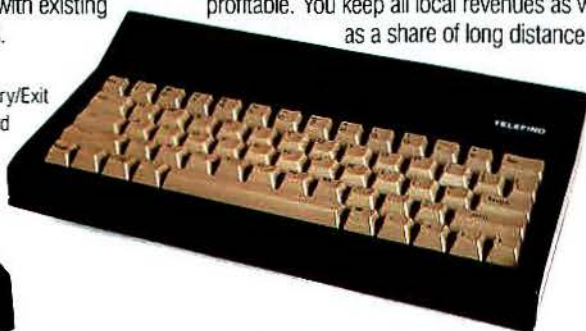




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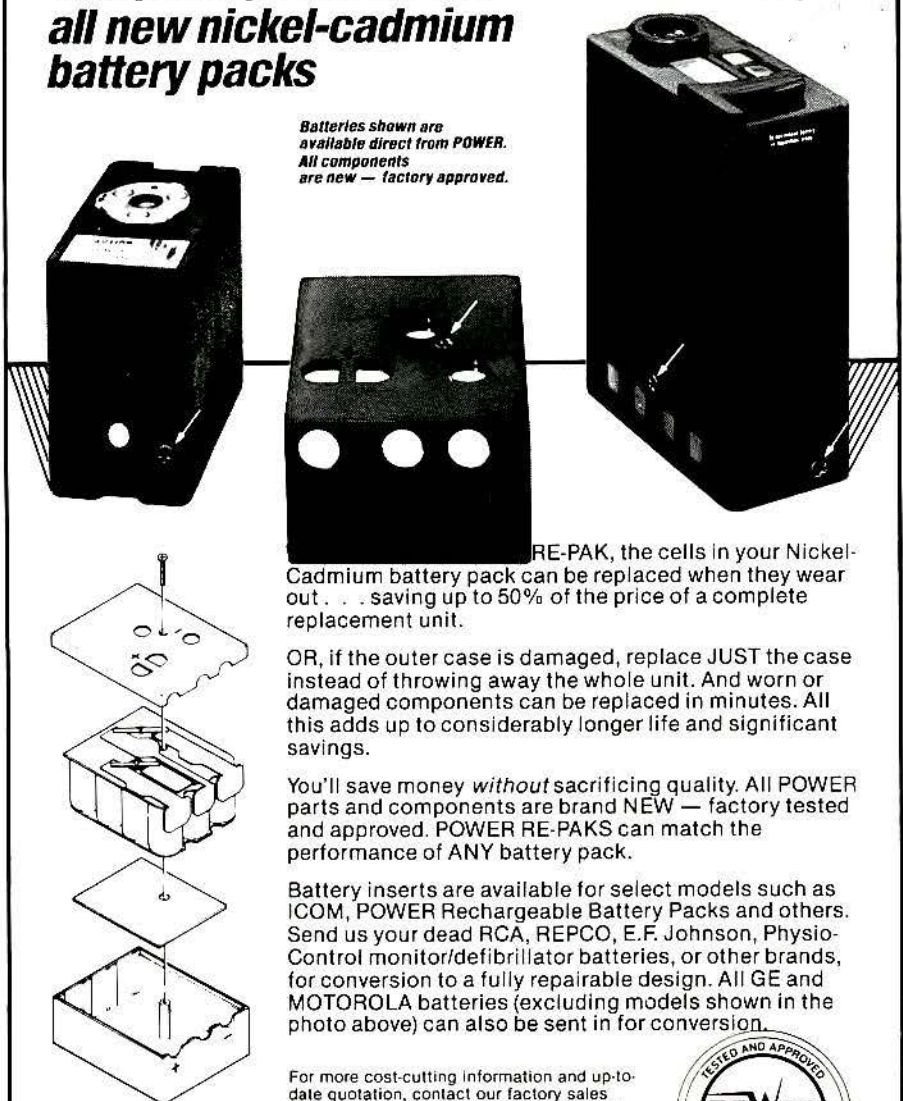
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MN, Minneapolis (612) 375-9517  
NJ, Clifton (201) 473-1001  
NJ, Totowa (201) 256-0455  
NY, Syracuse (315) 437-8387  
PA, Philadelphia (215) 922-1321  
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60 Dodge Ave.  
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203-239-3311

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404-424-8824

**Cadex Electronics Inc.**  
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Burnaby, BC, Canada V3N 3L6  
604-522-8046

**Cal Crystal Lab, Inc.**  
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Anaheim, CA 92801  
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800-854-XTAL

## Cut your phone cost by sending error-free data over your 2-way radio with the MFJ-2270 Packet Radio Controller



**\$299<sup>95</sup>**

**Instead of using expensive phone lines to send data, why not use your existing 2-way radio? You'll not only save phone line cost but you can even send data to places where there are no phones!**

By simply connecting a MFJ-2270 Packet Radio Controller to your 2-way radio and to any computer with a standard RS-232 serial port, you'll have a packet radio system capable of sophisticated data exchange.

The applications are endless. For example, you can send or exchange daily receipts, price changes, inventory and bookkeeping information to all your stores across the state. You can use it to connect warehouses to sales locations, to exchange files between computers, to send data from remote locations or to remotely control devices. You can send almost any digital data -- all error free -- fast and inexpensively.

Packet radio reduces frequency congestion because many independent users can share a single radio channel simultaneously. The user can receive data intended only for him.

You can use your normal voice repeater to extend your range or you can set up an inexpensive digital repeater (digipeater) using only a simplex radio and a MFJ-2270 Packet Radio Controller. You can link up to 8

digipeaters and cover huge distances simply, reliably and inexpensively.

You can receive data unattended and then process and print it whenever it's convenient.

It's easy to use by non-technical people. Only a few commands are needed for routine use but over 85 are available to custom fit your application.

Thousands of MFJ-2270s in actual everyday use -- all over the country and in many parts of the world -- have proven the reliability of these quality units. It uses the widely recognized AX.25 protocol so you can exchange data with other packet radio stations.

You can power it with 110 VAC or use 12 VDC for remote, portable or mobile operation.

The cost of setting up a packet radio system is less than you think. The cost of the MFJ-2270 Packet Radio Controller is unbelievable.

Find out more about packet radio. Write or call toll-free 1-800-647-1800 and talk with us about your applications. When you do, ask for our MFJ-2270 Packet Radio Controller brochure.

**Dealers:** Get in on the ground floor of the packet radio revolution! Call now and see how it'll add to your business.

**Call toll-free for information**  
**1-800-647-1800**

Dealer inquiries invited

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**Triletric/Neulink/Neutec**  
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San Diego, CA 92121  
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Mount Prospect, IL 60056  
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**Cellular Communications Corp.**  
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Laguna Hills, CA 92653  
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Deer Park, NY 11729  
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**Cellwave**  
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800-321-4700

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Lincoln, NE 68501  
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Winter Park, FL 32789  
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800-854-0547

**Communications Systems Inc.**  
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Seattle, WA 98109  
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800-222-5570

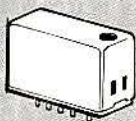


Tactel  
MI594008



Series for  
Veetac models

Motorola\*  
KXN1034,  
KXN1035



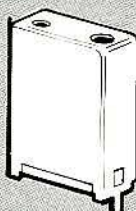
and others for  
MT-500 models

Tactel  
MI559230  
MI559241



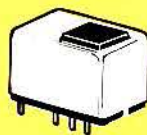
Series for 500/700/1000  
and ML-1000 models

Motorola  
KXN1086  
KXN1088



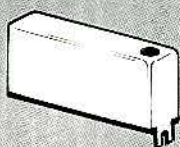
Series for  
Mitrek\* models

General  
Electric  
4EG25A10



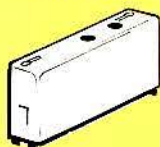
and others for  
various models

Tactel  
MI559766



Series for  
Tac-100  
model

General  
Electric  
19A701712GX



(2C) Series

Motorola\*  
TLN1083A  
TLN1082A



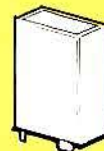
and others

Motorola\*  
KNX1024A



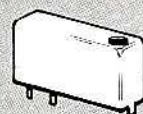
and others for  
MICOR\*  
models

Motorola\*  
KXN1040A  
KXN1041A



and others for  
MX series  
models

General  
Electric  
4EG28A13



and others for  
Sicom models

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ICM manufactures the TCXO Oscillators used in Tactel products, including the Tactel ML-1000, Tac-100 and other Veetac equipment. We can supply reconditioned elements for all other brands of equipment. Our half million dollar inventory changes daily. Call for immediate information on availability. Write or call for Channel Element Brochure.

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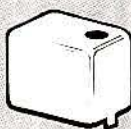
P.O. Box 26330, 701 W. Sheridan Oklahoma City, OK 73126-0330  
Phone (405) 236-3741 Telex 747-147 Facsimile (405) 235-1904

General Electric  
19A129393GXX  
19A137763GXX



Series

Motorola\*  
K1040/K1048



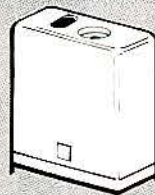
and others

Motorola\*  
TLN8967A TLN8968A



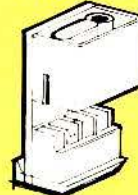
and others

General  
Electric  
19A130605GXX



Series

General  
Electric  
19A226962GXX



Series

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**SecureTalk™** is designed to block all eavesdropping on conversations between cellular telephones and the home, office or any other corded telephone equipped with **SecureTalk™**

**SecureTalk™** insures privacy by transmitting a scrambling signal over the voice signal, which can only be recognized and decoded by another **SecureTalk™**. **SecureTalk™** can also economically protect interoffice and other private conversations over regular corded telephones.

This model is small (7"x1.4"x4") and easy to install and operate, providing 32 different scrambling signal codes over 4 channels for maximum security.

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Belmont, CA 94002

Toll free: (800) 233-5973  
In Calif.: (415) 591-1400  
Telex: GRE BLMT 17-2069  
Fax: (415) 591-2001



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NJ. Paramus (201) 843-6400  
NJ. Union (201) 964-3333  
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800-652-9296

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214-631-0310

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**D&R Associates, Inc.**  
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309-685-0607  
800-223-2487

**Drive Phone Inc.**  
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Paramus, NJ 07652  
201-843-6400

Product Directory begins on page 10

# Tone Monitor Timekeeper™



Model TK-710

The TK-710 monitors all 37 standard CTCSS tones on any channel. Connects to any receiver, scanner, or tone panel. Ideal for community repeaters. The TK-710 lets you find out which tones are in use before assigning a new tone. Displays tone frequency as you moni-

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**Manufacturers of Automatic Number Identification (ANI) Systems, The Tone Monitor Timekeeper™, and Morse Code Station Identifiers.**

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**Energy Concepts Inc.**  
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**Etak, Inc.**  
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Menlo Park, CA 94025

**Exar Corp.**  
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408-434-6400

**Express Tower Co.**  
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**EZ Soft Business Software, Inc.**  
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**Fabrecon Development Corp.**  
P.O. Box 706  
Johnson City, NY 13790  
607-770-8134

**Ferritronics Inc.**  
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Niagara Falls, NY 14301  
716-282-7470

**REGIONAL SALES CONTACTS:**  
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**Ferritronics Ltd.**  
222 Newkirk Road  
Richmond Hill, Ont., Canada L4C 3G7  
416-884-3180

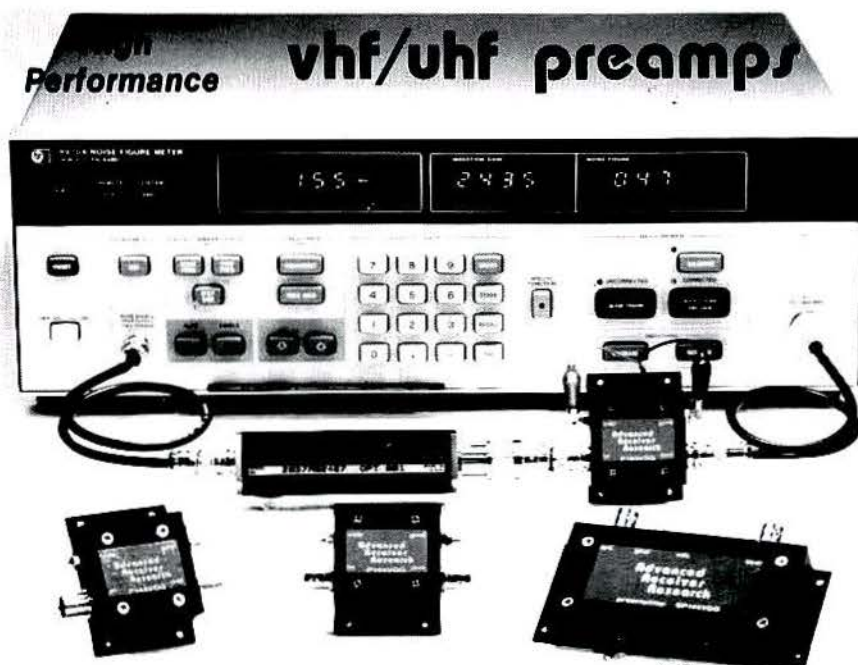
**Fitzgerald Telecommunications Inc.**  
635 East 185th St.  
Cleveland, OH 44119  
216-531-1313

**Fleet Credit Corp.**  
111 Westminster St.  
Providence, RI 02903  
401-278-6911

**John Fluke Mfg. Co.**  
P.O. Box C9090  
Everett, WA 98206  
800-426-0361

**Fort Worth Tower Co., Inc.**  
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817-457-3060  
800-433-1816

**Freeman Engineering Associates, Inc.**  
3100 Fifth St.  
Metairie, LA 70002  
504-831-7785



#### Receive only

	Freq. Ranges (MHz)	N.F. (dB)	Gain (dB)	Comp. (dBm)	Device Type	Price
P30VD, P35VD, P40VD, P45VD	30-35, 35-40, 40-45, 45-50	<1.3	15	0	DGFET	\$ 44.95
P30VDG, P35VDG, P40VDG, P45VDG	30-35, 35-40, 40-45, 45-50	<0.5	26	+12	GaAsFET	\$109.95
P150VD, P160VD, P170VD	150-160, 160-170, 170-180	<1.5	15	0	DGFET	\$ 44.95
P150VDA, P160VDA, P170VDA	150-160, 160-170, 170-180	<1.1	15	0	DGFET	\$ 56.95
P150VDG, P160VDG, P170VDG	150-160, 160-170, 170-180	<0.5	24	+12	GaAsFET	\$109.95
P450VD, P460VD	450-460, 460-470	<1.8	15	-20	Bipolar	\$ 49.95
P450VDA, P460VDA	450-460, 460-470	<1.2	16	-20	Bipolar	\$ 74.95
P450VDG, P460VDG	450-460, 460-470	<0.5	16	+12	GaAsFET	\$109.95
P800VDG, P830VDG, P860VDG	800-830, 830-860, 860-890	<0.6	19	+12	GaAsFET	\$119.95

#### Inline (rf switched)

	Freq. Ranges (MHz)	N.F. (dB)	Gain (dB)	Comp. (dBm)	Device Type	Price
SP30VD, SP35VD, SP40VD, SP45VD	30-35, 35-40, 40-45, 45-50	<1.4	15	0	DGFET	\$ 74.95
SP30VDG, SP35VDG, SP40VDG, SP45VDG	30-35, 35-40, 40-45, 45-50	<0.55	26	+12	GaAsFET	\$139.95
SP150VD, SP160VD, SP170VD	150-160, 160-170, 170-180	<1.6	15	0	DGFET	\$ 74.95
SP150VDA, SP160VDA, SP170VDA	150-160, 160-170, 170-180	<1.2	15	0	DGFET	\$ 86.95
SP150VDG, SP160VDG, SP170VDG	150-160, 160-170, 170-180	<0.55	24	+12	GaAsFET	\$139.95
SP450VD, SP460VD	450-460, 460-470	<1.9	15	-20	Bipolar	\$ 79.95
SP450VDA, SP460VDA	450-460, 460-470	<1.3	16	-20	Bipolar	\$104.95
SP450VDG, SP460VDG	450-460, 460-470	<0.55	16	+12	GaAsFET	\$139.95

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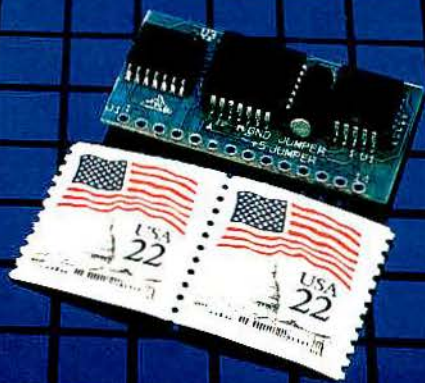
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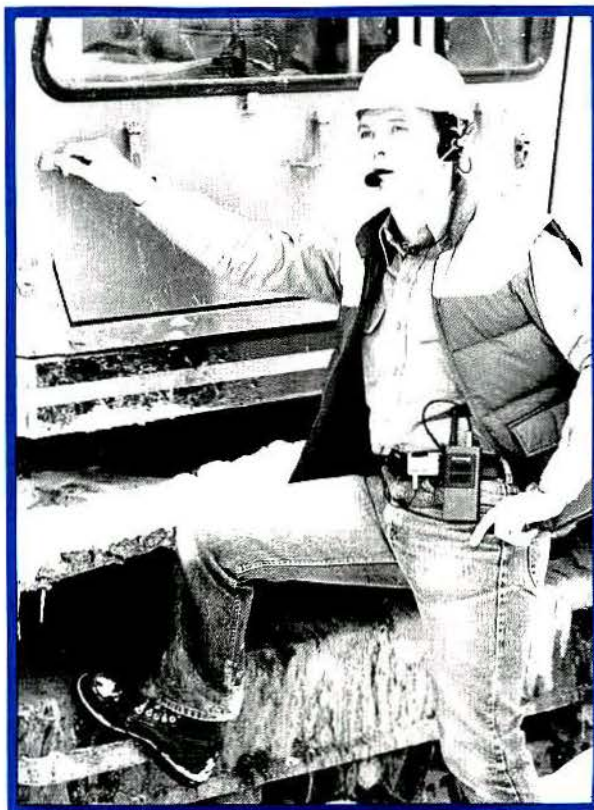
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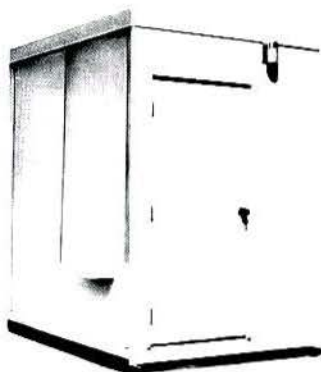
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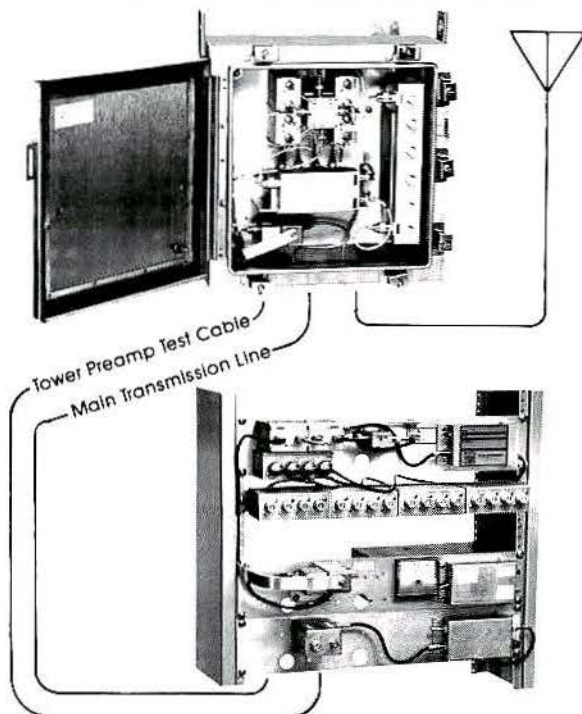
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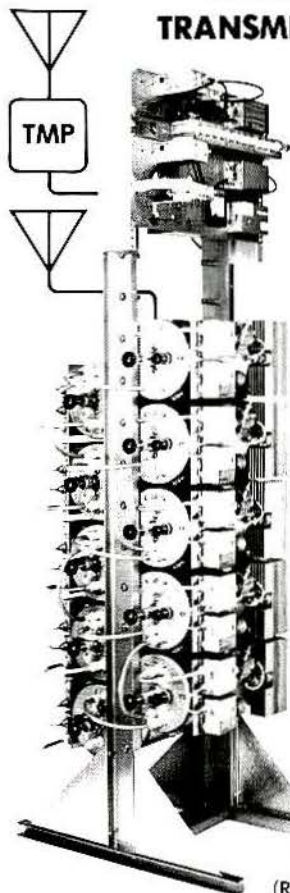


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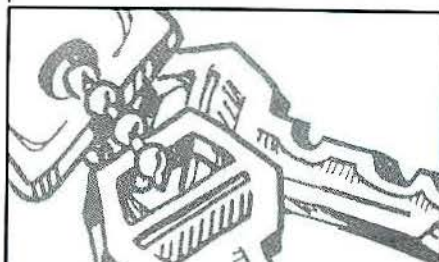
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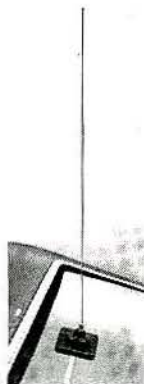
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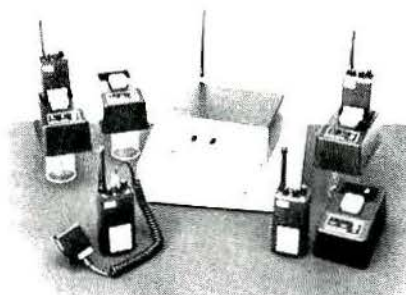
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(ASNA)  
1835 K St. NW  
Suite 203  
Washington, DC 20006  
202-331-7773  
Russell Fox, executive director

Associated Public-Safety Communications  
Officers (APCO)  
930 Third Ave.  
P.O. Box 669  
New Smyrna Beach, FL 32070-0669  
904-427-3461 or 904-428-8700  
Robert E. Tall, executive director

Association of American Railroads (AAR)  
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Washington, DC 20001  
202-639-2215  
L.M. Himmel Sr., executive director

Canadian Radio Common Carriers  
Association (CRCCA)  
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Suite 201  
Toronto, Ontario, Canada M4S 1A6  
416-483-5176  
Laura LaPrairie, executive director

Cellular Telecommunications Industry  
Association (CTIA)  
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Washington, DC 20036  
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Robert Maher, president

Communications Marketing Association  
(CMA)  
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Arlington Heights, IL 60005  
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Walter Ullrich, president

Energy Telecommunications and Electrical  
Association (ENTELEC)  
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Dallas, TX 75379-5038  
214-578-1900  
Martha Fike, executive director

Forest Industries Telecommunications (FIT)  
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Eugene, OR 97405  
503-485-8441  
Don McConaughy, president

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Chiefs of Police (IAFC)  
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Gaithersburg, MD 20878  
301-948-0922  
Jerald R. Vaughn, executive director

International Association of  
Fire Chiefs (IAFC)  
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Robert H. Ely, president

International Taxicab Association  
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Kensington, MD 20895  
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Alfred LaGasse, executive vice president

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Herb L. Massie, president

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and Educational Radio (NABER)

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National Association of Radio and  
Telecommunications Engineers (NARTE)  
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John Holmberg, executive director

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Commissioners (NARUC)  
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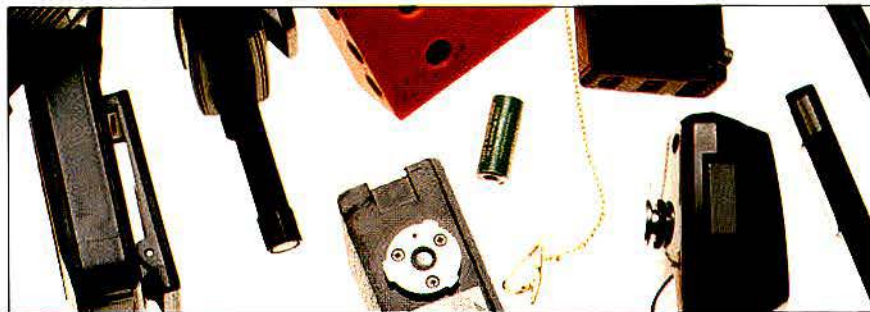
Radio Club of America  
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Fred M. Link, president

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Association (SIRSA)  
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# Telocator

## wrap-up/review

*Minilec Service's simple technical innovation promises to boost voice paging popularity. Nationwide paging grows as companies jockey for position. Telocator Network of America restructures for the future.*

---

**By Don Bishop**  
**Editorial Director**

Products, services and political activity captured the interest of those who attended Telocator Network of America's national convention Oct. 20-24 in San Francisco.

Voice storage and retrieval circuitry developed by Minilec Service promises to:

- boost voice paging popularity;
- offer an alternative to two-way radio users who are considering mobile data communications; and
- make it possible to record parts of a cellular phone conversation.

**To receive information from the companies mentioned in this article, circle on the Fast Fact Card on page 131 the numbers listed below:**

**Contemporary Group**

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**Cue Paging**

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**Metrocast**

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**Minilec Service**

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**National Satellite Paging**

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**Network Paging**

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**Telefind**

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The circuitry may boost the popularity of voice paging because it can store multiple messages and replay them at a rate slowed by a factor of three times or more. The pager can remain quiet or unattended during reception. Voice retrieval built into the pager allows the user to review messages and makes unnecessary a "quick draw" from the belt to raise the pager to one's ear in time to hear an incoming message.

Slowing the replay of messages received permits transmitting the messages at a higher speed. High-speed voice transmission reduces the airtime consumed. Methods that reduce airtime consumed per message always are popular among paging system operators.

**Record two-way messages**

Installed in a two-way radio, the circuit can record several separate messages under DTMF (Touch-Tone) control exercised by the dispatcher, so the mobile operator can replay them at will. The circuit also records the most recent 52 seconds of conversation for later replay, transmits recorded messages in functions similar to those of an answering machine or car alarm, and retransmits received messages in a simplex repeater mode.

Installed in a cellular phone, the circuit's "record" and "playback" buttons allow the user to record and replay selected segments of a con-

versation, such as driving directions or a list of items. Described as a voice scratchpad, this function offers a safe way for a driver to take notes. It works with handsets and with hands-free cellular units. The circuit can be configured to work as a telephone answering machine or to provide automatic dialing and the replay of a recorded message in conjunction with a car alarm.

**Nationwide paging**

Technology and marketing battles continue between nationwide paging services.

National Satellite Paging uses dedicated 900MHz transmitters and numeric pagers. Contemporary Group also will use 900MHz.

Metrocast shares existing VHF transmitters owned by radio common carriers to carry messages to alphanumeric pagers. Telefind will share existing RCC VHF and UHF transmitters.

Cue Paging uses FM broadcast station subsidiary carrier authorizations (SCAs, or subcarriers) to carry messages to alphanumeric pagers.

**Technology battle:** "A 900MHz system is the only one that sends a message through all its transmitters at once, covering the entire nation." "Subcarriers use FM broadcast station transmitters with higher power than conventional paging transmitters." "Existing RCC transmitter coverage areas are proven; 'dead spots' have been corrected."



**Marketing battle:** "Systems with the least new capital construction offer customers better rates." "Nationwide paging service customers will find that alphanumeric capability is essential." "My system covers more — cities — markets — land area — population — than yours."

Telefind vice president Ted Andros, speaking after the panel session, criticized Telocator for inviting representatives of National Satellite Paging, Contemporary Group and Cue Paging in the first place. "They have nothing to offer Telocator members," he said, "unless they hope to rent pagers to them individually. Only Telefind and Metrocast share revenues with RCCs in exchange for carrying paging messages. The others transmit

messages to customers using their own transmitters or via facilities leased from broadcasters."

A sixth nationwide paging company, Network Paging, is in the initial stages of connecting existing private carrier systems to relay messages nationwide on 152.480MHz.


#### Association struggles

Telocator itself continues to wrestle with issues that affect its health and growth, such as how to reconcile the interests of large and small members, and paging and cellular telephone members. The association has responded with weighted voting for members and changes in the board of directors.

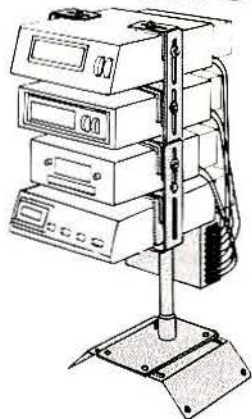
Mobile Communications Corporation of America senior vice

president of engineering Jai Bhagat was elected to chair what will become a single board of directors. The new board will be formed from what previously were separate cellular telephone and paging boards. (The paging board also represented conventional mobile telephone interests.)

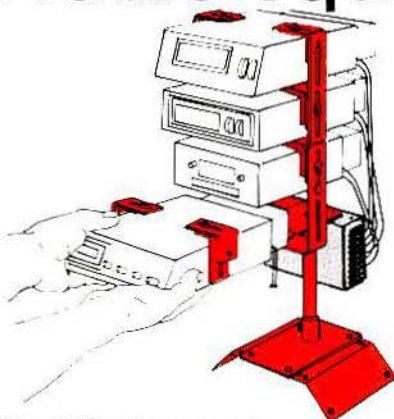
The new board will have 27 representatives from companies classified by size: large, medium and small, with nine from each classification. Each director will have one vote. Changes in the board structure are expected to be in place well before the next Telocator meeting to be held in St. Louis in the spring.

Members approved weighted voting, giving each member one vote per \$5,000 in annual dues. 

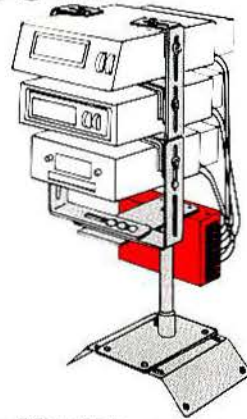
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# Practical uses for digital and packet

*Extending wireline integrated services digital network features to ground-based and airborne mobile telephone services may be made possible by advanced digital and packet switching technologies.*

---

**By Dr. Gregory M. Stone  
and Philip M. Raymond**

---

Mobile communications services long have been the "resting place" for simplistic and, often, antiquated technologies that make poor use of the limited radio frequency spectrum resource. Today, with extreme spectrum congestion in major metropolitan areas and increased user demands for communication of all types, ingenuity and innovation must be directed toward an effective technological solution.

## Analog ACSSB

In the late 1970s, communication pioneers such as Dr. Richard Harris mated the linear transmission technique known as single-sideband with syllabic amplitude companding, both having been developed in the 1930s to support wireless transatlantic telephone service. The result

is known as amplitude companded single-sideband or ACSSB, in mobile applications. Even Harris and his contemporaries recognized the limitations of strictly analog techniques because other communications developments were advancing rapidly in the digital arena.

But progress has been slow, not only in implementing efficient digital techniques but even with proven analog technologies such as ACSSB. Today, the "debate" continues in the mobile communications community over FM vs. ACSSB.

## Radical direction

A radical new technological direction for mobile communications emphasizes integrating bandwidth-efficient digital and time-hopping multiplexing technologies with a spectrally efficient application of direct-sequence spread-spectrum transmission techniques.

The benefits of this approach are multifold:

(1) bandwidth and spectrally efficient modulation; and,

(2) time-hopping multiplexing techniques

are employed to conserve precious spectrum. The techniques are digitally based, thus permitting integrated services digital networks (ISDN) to be implemented in mobile communications. A properly engineered digital spread-spectrum system may be overlaid upon existing services and frequency bands, caus-

ing insignificant and unnoticeable interference, thus dramatically increasing spectrum use by serving new users and by assuring the non-obsolescence of existing services.

Spread-spectrum transmission also affords users some immunity from interference from other users or from an adversary intent on jamming the communications. Such a system may be encrypted easily too. When encryption is combined with the broadband nature of spread-spectrum modulation, encryption offers not only communications privacy but some degree of true communications security.

## Applications

Three applications of this time-hopped, direct-sequence spread-spectrum concept immediately come to mind. First, to provide for reliable aeronautical mobile communications, existing 800MHz to 900MHz mobile services may be overlaid. Second, new communications services may be established by overlaying the 900MHz (L-band); 2,400MHz (S-band) industrial, and scientific and medical (ISM) spectrum; and 1,200MHz (L-band) radiolocation and amateur allocations. Third, if information is processed properly and packetized, the proposed Geostar navigational satellite, which already employs a packet version of time-hopping, direct-sequence spread-spectrum, could provide interactive voice, data

---

Stone is director of advanced project development with Sachs/Freeman Associates, Lake Bluff, IL. He previously was systems engineering director for Airfone. Stone has a Ph.D.E.E. and is a Fellow in the Radio Club of America. Raymond is a senior engineer with Sachs/Freeman and previously was a group leader with Airfone. He has a B.S.E.E. and is a member of IEE, United Kingdom. Opinions expressed in this article are the authors' and do not necessarily represent those of Sachs/Freeman or other staff members. The authors thank Fred A. Schmitt for his assistance in preparing this article.

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and video service to terrestrial, maritime and airborne users.

The reason why systems employing direct-sequence spread-spectrum techniques may be overlaid on existing services is explained easily in terms of spectral power density per unit bandwidth, expressed in watts of power present per hertz (cycle/second) bandwidth. Spread-spectrum techniques reduce the power present per hertz, making detection by systems with narrow bandwidths difficult. In practice, direct-sequence spread-spectrum energy appears as a slight increase in a conventional system's noise floor and is undiscernible from normal variations in background noise.

For example, a typical FM mobile radio transmitter has a transmitted

power bandwidth of approximately 16kHz. Assuming a transmitter power of 100W, with no antenna gain or line loss, the effective radiated spectral power density, per unit bandwidth, would be  $100\text{W}/16\text{kHz}$  or  $6.25 \times 10^{-3} \text{ W/Hz}$ . A properly designed direct-sequence spread-spectrum system suitable for overlaid use, having the same 100W effective radiated power and a spread bandwidth of 40MHz, would have a spectral power flux density of  $100\text{W}/40\text{MHz}$  or  $2.5 \times 10^{-6} \text{ W/Hz}$ , which is 1/2,500th the power or 34dB below the conventional systems power density per unit bandwidth.

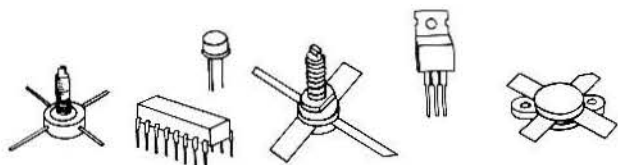
What is most important to realize is that assuming the future of communications and information trans-

fer is in the area of ISDN, efficient, integrated networks mandate the application of bandwidth and spectrally efficient technologies. Digital signals *always* occupy more spectrum than their analog counterparts, but the future of efficient bandwidth and spectrum use is contingent upon the proper selection of robust coding, modulation, multiplexing, transmission and detection system technologies.

#### Integration of voice and data

Historically, voice and digital data have had to be handled over separate (or different) transmission media due to their different characteristics; i.e., analog vs. digital. The years have brought changes in fixed communications services with the

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general acceptance of the 1.544mb/s DS-1 datarate standard for fixed, private, digitized speech and data networks. Today, digital channel bank equipment permits the economic integration of speech and data.

But integration of voice and data has been constrained by the need to allocate discrete segments of spectrum for data or for voice, segments that are unused during periods of inactivity. In telephone practice, certain techniques have been employed to minimize the bandwidth inefficiencies through adaptive bandwidth allocations, but at high cost and with limited success. In the mobile communication services, FCC regulations generally have treated data transmission as a sec-

ondary use of allocated bandwidth.

Today, relatively narrowband digital systems are common in the mobile community, both in the form of digital voice for privacy and in the form of digital data systems. But efficient integration of digital voice and data has not been accomplished and cannot be accomplished so long as current crude technologies continue to be used. Even trunked communications systems (both cellular and non-cellular) use inefficient modulation and transmission practices emphasizing analog information transfer.

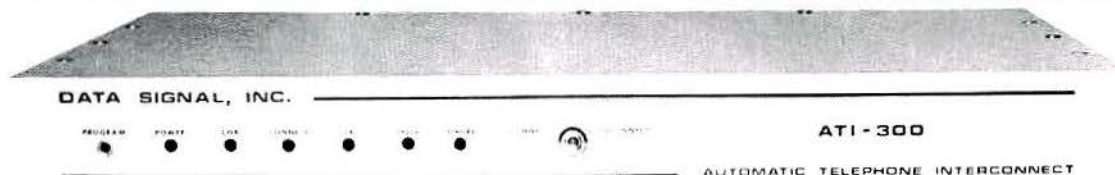
A network that efficiently accommodates all types of information, including speech and digital data, is required. Such an ISDN combines digitized voice and data in a packet-

switched network. In this system, each packet node samples all information channels and sends information to the correct address only when the information channel is being used.

For example, during a spoken conversation, one direction of the channel is used at a time. The reverse direction can be used to convey part of another conversation. Thus the packet switch has some features characteristic of multiplexing, including the requirement for high transmission bit rates compared to the individual channel information rate. Otherwise, the multiplexing (packetizing) efficiency would be low or the blocking of channels high.

The proposed time-hopped,

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- Toll restriction per user (local or remote)
- Two-tone pager
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- DTMF or Rotary Overdialing
- Programmable Voice after Page
- Auxiliary Relay for Channel Control
- Three Programmable Relays for Remote Control
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- Dial Tone Disconnect
- Telco Go-ahead Tone (Programmable)
- Dip Switch Programmable Timing
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direct-sequence spread-spectrum concept may accommodate the requirements of packet information transmission, fostering the transition to ISDN.

#### Impact on cellular

Cellular mobile communications services now are available in many parts of the country. Although cellular generally provides good voice service, it does not have the capability for ISDN features now being advanced by the fixed telephone network providers. These features include integrated voice and data, high-speed signaling schemes and video transmission. The next-generation cellular systems must provide for features transparent to the public switched tele-

phone network, including ISDN. Furthermore, because most users wish to have their business and personal telephone conversations and/or information transfers kept confidential, effective means to implement a robust communications privacy capability must be provided.

To provide ISDN features and communications privacy, a digitally based cellular network is needed. In response to this need and to increase the bandwidth and spectrum efficiency of cellular communications, certain proposals are being considered in Europe for digitally based time-division multiple-access (TDMA) cellular techniques using 16kbp/s digital speech. These TDMA techniques differ from current cellular techniques, which are

referred to as frequency-division multiple-access (FDMA). With FDMA, channels are frequency-based and use 25kHz to 30kHz each. In a TDMA system, channels are time-based. A slice of spectrum (300kHz, in one proposed technique developed by Ericsson) is divided into time slots, in this case permitting simultaneous use by 10 users. An American company, International Mobile Machines, has proposed a similar TDMA technique that would permit 40 users simultaneously to share a 300kHz spectrum slice.

Although these time-hopping TDMA techniques hold great promise, they do not employ direct-sequence spread-spectrum for transmission and thus cannot be overlaid upon existing allocations to increase

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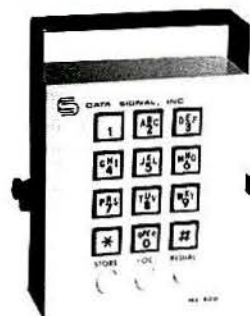
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spectrum use substantially. Nevertheless, the authors strongly support and endorse the application of low bit rate digital voice in a time-hopped (TDM or TDMA) implementation for future terrestrial cellular or common carrier uses.

### Second-generation cellular

Considering the physical plant and subscriber set investment in cellular today, phasing-in a second-generation, digitally based cellular system may be quite a challenge. Although frequency-hopped and time-hopped technology may be the ultimate solution where existing interstitial cellular frequencies are used, attempts to modernize the existing cellular service might only be as widely accepted as ACSSB is now. On the other hand, establishing a new digital cellular service overlaid on either the existing L-band or S-band ISM or L-band radiolocation and amateur allocations holds great promise if time-hopped, direct-sequence spread-spectrum is employed.

For example, a time-hopped, direct-sequence spread-spectrum system operating with 40MHz of overlaid S-band radiolocation spectrum could be designed as follows: Assuming the use of low bit rate voice coding with a process such as vector-quantized linear-predictive coding (VQ-LPC) operating at bit rate of 4.8kb/s, time multiplexing with a resulting 50-channel complement and an aggregate information rate of 500kb/s easily is achieved. This 500kb/s information rate signal, driving a direct-sequence spread-spectrum modulator with 2-psk modulation, would "spread" this signal over the 40MHz bandwidth. The result would be a signal with 1/1,600th the power per cycle-per-second bandwidth of a conventional frequency-modulated signal. As was stated previously, the reduction in spectral power density stated in watts-per-hertz (cycle-per-second)

as provided by direct-sequence spread-spectrum is the key to overlaid spectrum use without harmful interference.

### Impact on aeronautical mobile

Application of time-hopped, direct-sequence spread-spectrum technology to aeronautical mobile communications may be of the utmost importance. Today, the future of aeronautical mobile communica-

---

## *...two unique solutions to aeronautical mobile communications are foreseen.*

---

tions is uncertain as various factions clamor over the remaining 800/900MHz reserve spectrum. But two unique solutions to aeronautical mobile communications are foreseen. The first involves the spread-spectrum overlay of the existing 800MHz and 900MHz services; the second involves use of excess transponder capacity of a global positioning satellite.

In the several years leading to the FCC's allocation of 800/900MHz reserve spectrum, proposals were made to permit shared aeronautical and cellular spectrum use. For various reasons, the commission deemed such an arrangement inadvisable. The FCC's decision was correct because the proposed modulation techniques were then and today remain incompatible with present cellular service and a likely second-generation cellular service using narrowband digital channels.

But the current 800MHz aeronautical mobile telephone service, which lacks a permanent allocation, finds a permanent frequency via spectrum sharing. An aeronautical service represents an ideal spectrum-

sharing partner for several reasons, including the fact that there is a finite and relatively small number of potential aircraft to be equipped—for sake of argument assume there are 5,000.

In light of this fact and considering the service's method of operation, it is likely that fixed stations supporting the operation also would be relatively few and their locations easily controlled. Therefore, if a well-engineered time-hopped, direct-sequence spread-spectrum system were overlaid on existing terrestrial systems employing either FM, ACSSB or other types of "normal or narrowband" transmission techniques, airborne spread-spectrum usage would be possible without causing harmful interference to existing services. Additional interference management and control could be effected through the careful selection of fixed-station spread-spectrum sites and by using antennas that suppress signal radiation at and below the horizon. If provision must be made for the telephones to be used while the aircraft may be on the ground, RF power emitted by the aircraft-mounted transmitters could be controlled to minimize any interference during this mode of operation.

### Aeronautical mobile system

A time-hopped, direct-sequence spread-spectrum system could be designed specifically for overlaid aeronautical use in the 800MHz to 900MHz band. High, near-toll-quality voice coding would be effected through the use of vector-quantized linear-predictive coding (VQ-LPC) at a rate of 4.8kb/s. With redundancy coding and signaling, this rate would be increased to 9.6kb/s. A time-hopped, time-division multiplex scheme would be employed that would accommodate 50 TDM "channels" each operating at the 9.6kb/s rate. The time-hopped multiplexer would operate



at an information rate of 500kb/s, including signaling requirements. With a 100MHz spread bandwidth, a direct-sequence code rate of 50Mb/s would be employed. Airborne and terrestrial transmitting equipment would operate with a 100W power output and an effective dipole radiated power of 200W. The radiated power density per unit bandwidth would then be  $200W/100MHz$  or only  $2.0 \times 10^{-6} W/Hz$ .

The time-hopped direct-sequence spread-spectrum approach has several other benefits that would be useful in aeronautical service. For example, in selecting the appropriate direct-sequence operating limitations, the direct-sequence coding may afford a particularly robust type of ranging that may be used for

accurately selecting the best ground station for communication. Of course, the ranging data also could be used to track aircraft, with the tracking information then becoming useful in placing calls from a ground station to an aircraft.

Using these digital technologies greatly reduces the size and weight of the communications equipment. Transceiver design is simplified because time switching eliminates the need for separate transmitters and receivers and their associated filtering requirements. Therefore, one time-hopped direct-sequence transceiver could accommodate as many as 50 simultaneous users. If traffic engineering dictates, more than one transceiver could be simultaneously operated to provide

50 more channel trunk complements if orthogonal direct codes are selected.

#### What's ahead for digital

The future of bandwidth and spectrally efficient digital technology looks promising. With the current, mature VLSI and MMIC technologies available, no technological barriers are foreseen that would prevent time-hopped, direct-sequence spread-spectrum systems at frequencies approximately as high as 2,500MHz from being implemented soon.

Already, Geostar is staging itself to launch a geosynchronous earth satellite that will translate L-band and S-band packetized direct-

*Continued on page 141*

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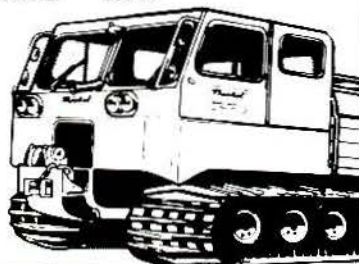
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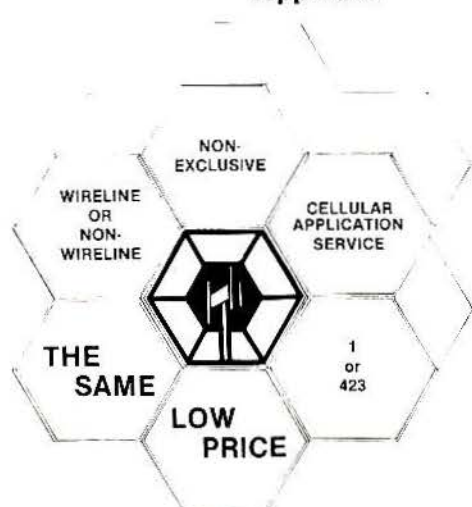
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# Lowband paging system uses 50 transmitter sites

*PageAmerica's New York paging system simulcasts on a 35MHz frequency to the nation's largest market. The construction details serve as a model for other major system projects.*

**By Richard Contrera**

In 1983, PageAmerica resold paging services in several major markets throughout the United States. The management decided that if the company was to grow and become more profitable, it must construct and operate its own paging systems in a number of major markets, of which New York was on top of the list. Considering the highly competitive nature of this particular market and the fact that several quite large and well-established systems existed, its challenge was to build a 35MHz wide-area paging channel with coverage to match that of existing systems and with the reliability that usually comes only after years of service. The 35MHz frequency has the reputation of being difficult to construct and unpredictable. The time frame was tight. And the city is the country's largest.

The construction challenge was met. Eighteen months after the start of construction, PageAmerica had a system in operation with coverage from Hartford, CT, to the north, the Hamptons of Long Island to the east, Cape May of New Jersey to the south and the Pennsylvania border to the west. It gained the reputation

for quick, reliable and high-quality service at the same time.

## Initial FCC applications

Upon acceptance of the plan, we filed 30 separate site applications with the FCC on 35.24MHz. They defined the overall proposed coverage area perimeter as well as those areas that would require fill-in transmitters later. The criteria for selecting the sites then were not necessarily based on rigorous site analysis but in many cases on the basis of availability. As construction permits (CPs) were granted and construction deadlines established, a more sophisticated approach to site analysis, as well as system design, began to unfold. This design eventually led to shifting several sites originally selected, as well as to adding almost 15 more.

## Defining the system

The first step for a project engineer in constructing an RF telecommunications system is to define the major characteristics that will describe its basic functions, goals and costs. The following questions define those parameters:

- What service is to be provided?
- How is the service provided?
- Where is the service to be provided?
- What grade of service is to be provided, and what is the target for probability of message receipt?
- What is the potential revenue,

and what are the operating costs?

- What are the costs, and how long will it take?

The marketing staff must answer several of these questions, but all items affect the overall design. In our case, both marketing and engineering worked together to define and refine the type of system and the services it would provide.

The service to be offered was simple: nothing but paging. Of the paging techniques available, digital modulation offered the optimum combination of reliability, speed, quality and versatility. The simple NRZ-FSK binary format tolerates low signal strength, noisy environments, and many discrete codes extremely well. Keeping the system solely digital makes the transmission more efficient because the terminal and the transmitters need not alter batching techniques nor shift modulation from digital to analog and back. It simplifies and reduces time needed to send pages of mixed format. It also maximizes the number of pagers on the channel and therefore increases the potential revenue the channel can produce.

We knew the system would cover the New York tri-state area, and we knew it would be impractical to build it to offer the same grade of service in all areas. Manhattan and the immediate surroundings include heavily constructed and densely packed buildings. Topography surrounding New York is flat, like

Contrera is engineering vice president of PageAmerica Group, Hackensack, NJ. He holds a B.S.E.E.



Long Island, and rugged, like the the Ramapo mountains of northern New Jersey. We further defined areas with dense population, commercial construction and transportation routes, and we decided where heavy or light penetration would be necessary. The next challenge was how to design a cost-effective paging system quickly using a lowband frequency.

#### Propagation design

To design the paging system, we needed to know how a 35MHz channel would perform and under what circumstances. We began by speaking to traditional paging and two-way radio common carrier (RCC) system operators; most major transmitter, antenna and terminal manufacturers; as well as several consultants and highly regarded experts. Everyone had a different opinion. No one had a clearly defined method to predict, to a reasonable degree, the penetration and RF coverage that could be achieved by various placements of base stations.

The Carey method and its associated curves make for attractive sales tools, but, unfortunately, they sometimes misrepresent actual coverage. This is especially true if the coverage area includes topography that varies considerably over short distances and that contains heavily constructed buildings.

The FCC Carey procedures use an average elevation technique that can disguise coverage problems that result from sharply elevating terrain gradients. The method requires drawing eight radials (one every 45°) from the point of transmission and averaging elevation from 2 to 10 miles along those radials, as represented on a U.S. Geological survey map or an equivalent digitized database.

Ambient noise levels and receiver input level data were obtained from studies made in 1952 using the 152MHz band. Performance and

levels of service from that channel then were used as the basis of performance in the 35MHz to 44MHz bands. A factor was added to the

minimum required signal to achieve the so-called 90% reliability grade of service. Little attention is given to factors such as slow fade, fast fade,

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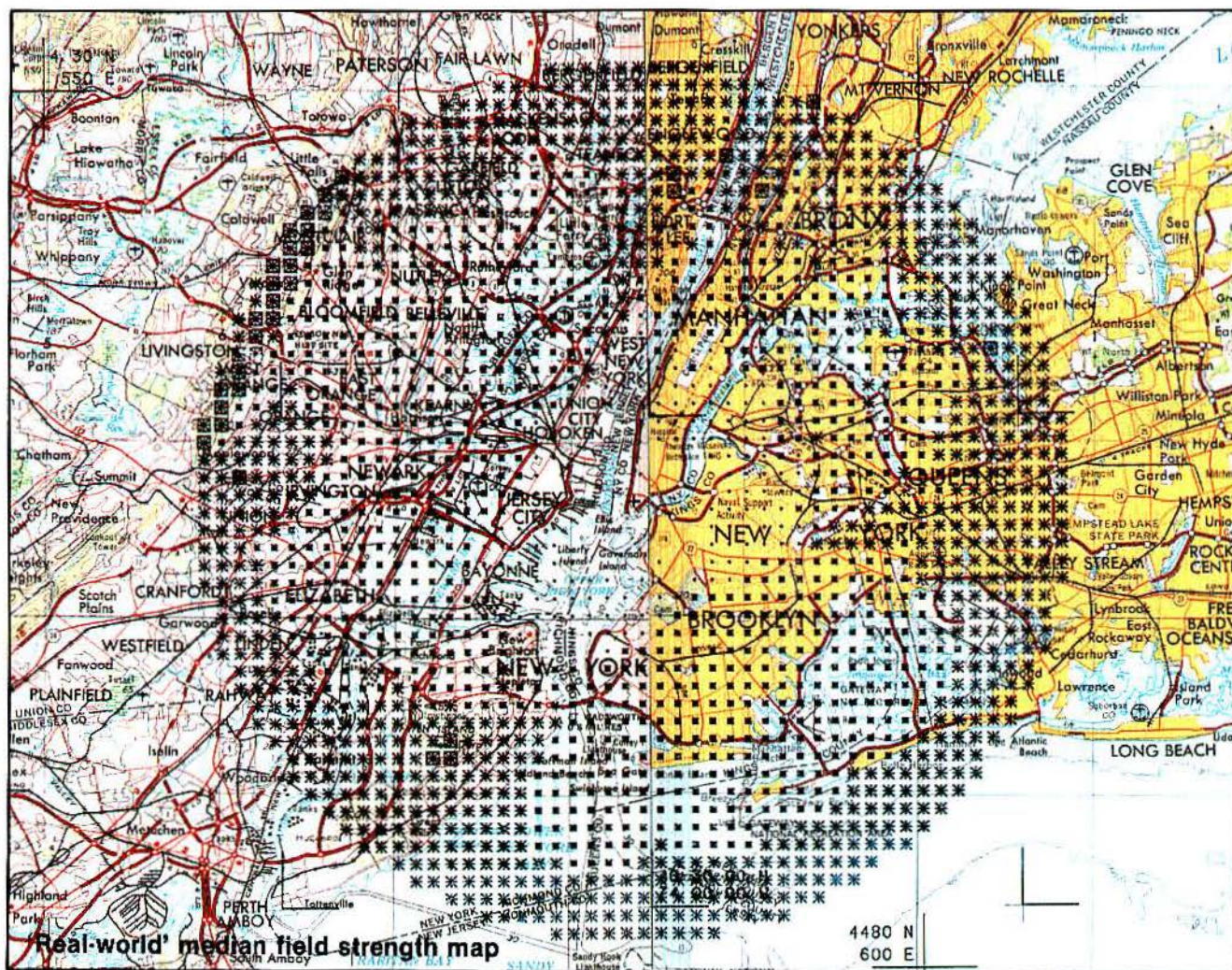
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#### Run description: 20 Exchange 35.24MHz page

Date: 18-Nov-86

EBU/CCIR clearance angle method  
median transmission loss: okumura urban  
median field strength codes:

- = > 65.0dBμ
- \* = 65.0 ~ 55.0dBμ
- = 55.0 ~ 45.0dBμ
- ◊ = 45.0 ~ 35.0dBμ
- = < 35.0dBμ

base site [+]: New York, NY

N. lat: 40° 42' 23.0"

W. lon: 74° 0' 40.0"

x'mitter rad center: 762ft amsl

receiver rad center: 4ft agl

frequency: 35.24MHz

plot specifications: radius: 25km; grid inc: 1.00km

scale: 1:403,226; 10.242km/in; 8.385mi/in

digital terrain data: NGDS 30-sec point elevation data (TCP-0050)

site elev: 0.0ft; terrain inc: 0.25mi

basic 1kW data file: data-file.dat:2

base transmit/mobile receive

base transmit information

transmitter output power = -5.32dBk (293.8W)

transmitter system gain/loss = -1.76dB

antenna: PD-1142

omnidirectional

gain/loss = 0.0dB

ERP = -7.08dBk (195.9W)

med fs data file: data-file.sig:1

plot file: 3B1800B27.PLV:2

Figure 1. PageAmerica uses 'real-world' models of actual RF levels shown on topographical maps to construct an overall model of the paging system. Comp Comm, a New Jersey-based engineering firm, supplies projections for each site such as the one shown above for a site at 20 Exchange Place, New York.



movement of the receiver, attenuations due to foliage, and size and type of buildings, not to mention the latest communication techniques, including simulcasting and digital modulation.

Our investigation included several studies that were helpful in expanding our understanding of modern lowband modulation techniques. Some of the more useful were: Bullington, *Radio Propagation Fundamentals*—1956; L.P. Rice, *Radio Transmission in Buildings at 35 and 150 mc*—1958; C.D. Gray, *The Simulcasting Technique*—1979; T. Hattori, *Theoretical Studies of a Simulcasting Digital Radio Paging System Using a Carrier Frequency Offset Strategy*—1980 and various papers by major RCC equipment

manufacturers. (This is only a small sample of the studies available on the subject, many of which are available at the IEEE library in New York City.)

Using this general background, we began to formulate a method of more accurately predicting coverage and penetration of proposed transmitter locations. During discussions with Comp Comm, a New Jersey-based engineering firm, we found its "real-world" studies had the basis of the model we needed. (See Figure 1 on page 124.)

Although, at the time, the model was theoretical at 35MHz, it could provide actual RF levels (dBμ per meter) over highly detailed topographical maps in a 25km radius from the antenna. This was a signi-

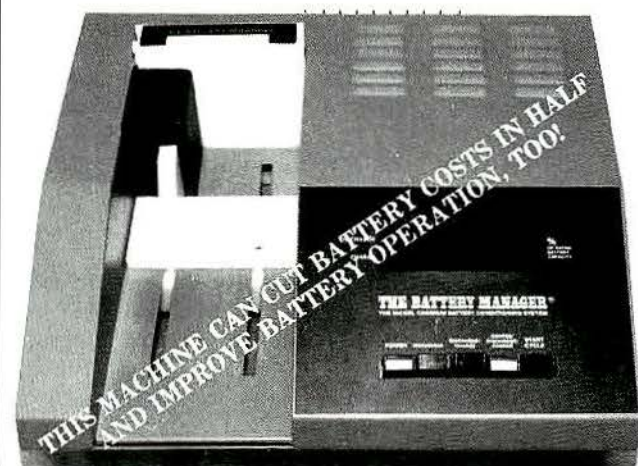
ficant step in achieving a more accurate picture of the interactions of a specific antenna, power level and the effects of terrain on the standard RF propagation model.

Having tested to account for factors such as slow fade and adding a factor for the required 90% probability (based on using a pager with a 1μV receiver sensitivity), we began to construct a usable model. To our advantage, the 35MHz band has significantly less attenuation due to foliage. The signals travel over greater distances at lower frequencies than they do at higher frequencies. To our disadvantage, 35MHz signals have a reduced ability to enter and bounce in buildings.

To account for these variations, we adjusted the real-world levels by

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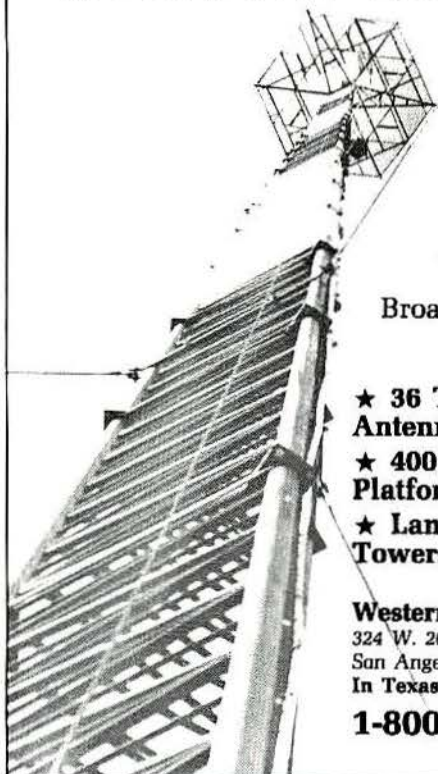


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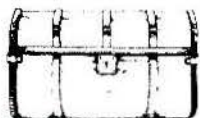
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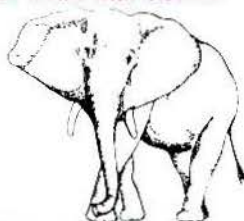
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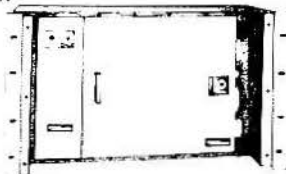
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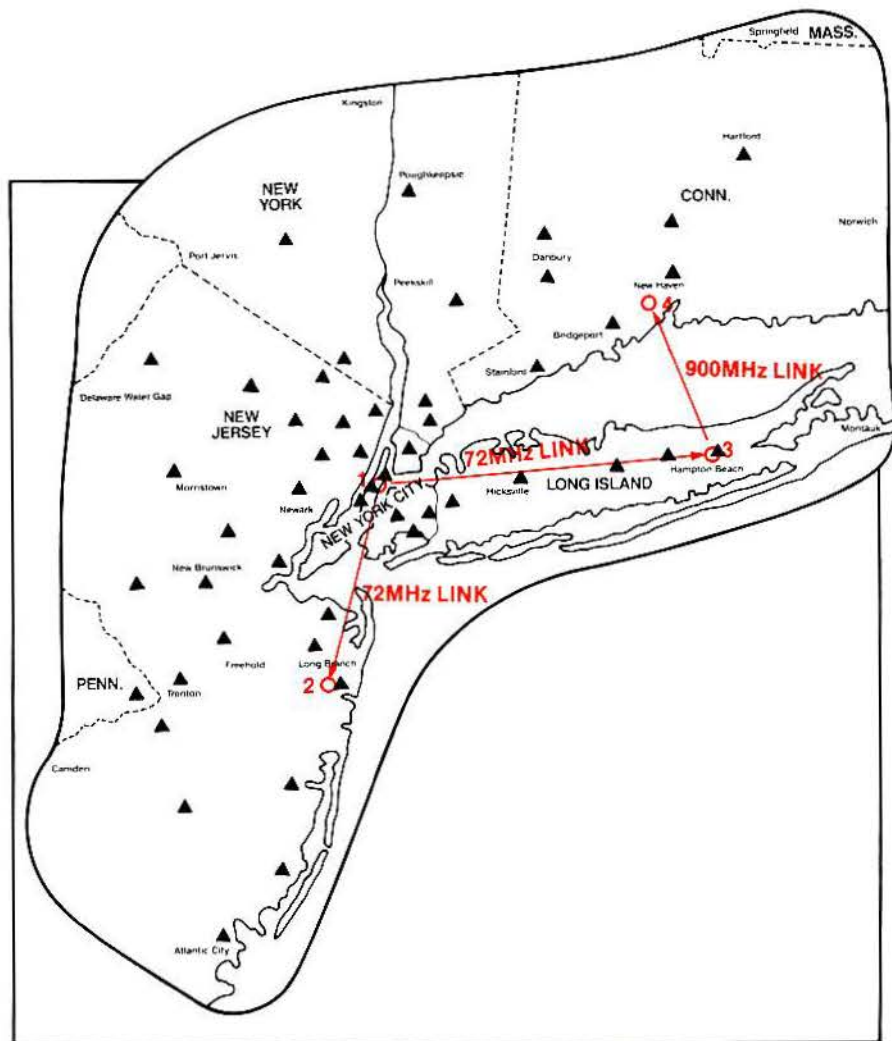


Figure 2. The system's radiolink includes a redundant link transmitter in mid-Manhattan and three redundant link repeaters in Long Island, Connecticut and New Jersey. All 50 base station transmitters operate from the four link transmitters.

several factors (based on our field tests and available studies). We varied these factors depending on population density, transportation routes and average building size contained within the radius.

As an example, the levels as displayed graphically over a 25km radius from an antenna located on a building roof might indicate areas of field intensity from 65dB $\mu$  or greater to 35dB $\mu$  or less. If this particular area contained heavy buildings and we needed a 90% or better probability, we discounted coverage in all areas that had field intensities below a certain level. This reduced the predicted effective coverage of the proposed location and helped us to decide whether to carry out the installation as planned

or find a better site. To account for building penetration alone, we chose a conservative 30dB reduction factor for heavy buildings and a 25dB reduction factor for medium-sized buildings.

### RF hardware design

The hardware design was based on providing reliable and high-quality service at low operating costs. To achieve this goal, financial considerations sometimes took the back seat.

The system would be controlled exclusively by radiolink, and paging messages would be simulcast. This decision was easy because the alternative to radiolinks were telco circuits, and trying to manage 40 to 45 sites with phone lines is simply un-



thinkable. Simulcast systems offer several advantages and, if the system is properly maintained, no real disadvantages.

Because we had decided to restrict the system to a digital format, the small frequency offsets and close modulation tolerances required for analog paging were reduced substantially. We gained speed and reliability. With a system this large, the operating costs are high, and the system must operate at peak efficiency. We were confident that the New York market could supply the demand for our services in sufficient volume for an appropriate pay back.

The radio linking consists of one redundant link transmitter in a building in mid-Manhattan and

three redundant link repeaters in Long Island, Connecticut and New Jersey. (See Figure 2 on page 126.) From these four transmitters, all 50 base stations are operated. All four are backed with uninterruptible power supply (UPS) systems.


Because of the high radio frequency interference (RFI) levels at some locations, we installed crystal-controlled filters and amplifiers to eliminate noise that might otherwise have entered the link receivers. Noise is particularly a problem in link repeater sites because, if not filtered, it would be repeated and would affect all the base stations linked with the affected repeaters.

At many sites, including a duplex on our base antenna served both to transmit the paging frequency

and to receive the link control signal. Thus, we saved the expense of installing a second antenna.

The design did not specifically incorporate isolators and cavities, although we knew at least 50% of our sites would need one or both to help combat intermodulation products as well as television interference (TVI). It was difficult to predict, however, what we would need until we began each installation project.

Generally, omnidirectional antennas were specified wherever possible. Particularly in the cities, the last thing we needed was a high-gain, narrow-beam antenna. The goal was to distribute power evenly. Radiating down was just as important as achieving distance. This was correlated with data from the 1958



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Bell System studies that indicated lower signal strength losses on higher floors of buildings than in the lobbies.

The first choice for antennas was the Celwave 1142 or its equivalent. The catch, however, was that an antenna such as the 1142 requires at least one-half wavelength spacing between it and the nearest reflector or other antenna. At lowband frequencies, that is about 15 feet. Finding buildings and towers with available space is not easy in a major metropolitan city.

A possible solution is to install a Celwave 322 (or equivalent), a two-element 2.5dB gain antenna with a precut harness. This works fine on most towers (although it takes two antenna positions), but it still can be

bothersome to mount on a building. The PD128 (or equivalent) is another possible solution, but again, the long ground plane elements can be an unwanted mechanical impediment to a building owner who wishes to fill every last inch of rentable space from his roof.

Accordingly, we used various antennas to fit the individual site requirements. As far as the brands of antenna are concerned, we used Celwave, Decibel Products and, in a few instances, perhaps one or two others. There is no magic in antenna performance. Many claims antenna users make are purely subjective and rarely backed by in-depth and rigorous electrical performance comparisons.

Generally, an antenna's mechan-

ical design is predetermined by the specifications for its frequency, gain and pattern, so overall dimensions of different manufacturers' antennas are quite similar.

The most important factors in choosing an antenna brand are the customer's confidence that the antenna meets its published performance specifications and the unit's mechanical soundness and durability. Although customers rarely can confirm that an antenna meets published specifications unless they have a test range, visual inspection may confirm the mechanical integrity and durability to some extent.

Because the antenna is possibly the most significant element of the RF system and it is beyond the

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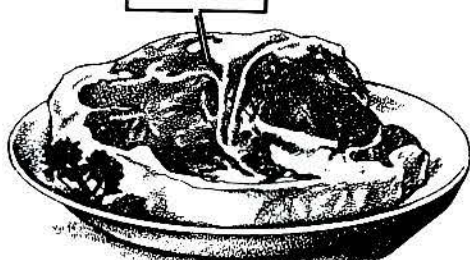
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resources of most customers to test the vertical and horizontal pattern, customers purchasing many antennas should inspect the manufacturing facilities and view for themselves both the assembly and final test. Also, *always install the antenna to manufacturer's specifications.* Significant pattern variations due to incorrect installation usually are not revealed by a simple voltage standing wave ratio (VSWR) test, but such variations may cause substantial coverage problems.

#### Terminal and facilities

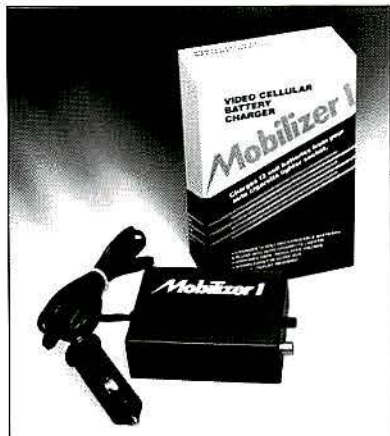
We considered several terminals and finally chose a Spectrum Communications PX2000L. It offered a reasonable compromise in speed, capacity and flexibility. The fact

that Spectrum's facilities are within our coverage area gave us confidence that we would get excellent service.

The initial unit was designed for 30 trunks, but once it was installed, it quickly grew to 50. We ordered a 48Vdc unit because our design called for an Elgin 48 battery system to power the terminal. This system supplies operating voltage to the terminal directly from batteries while the batteries are being charged constantly. Battery capacity is sufficient to operate the terminal for 24 hours during a utility failure. A backup generator recharges the batteries during a prolonged failure. The battery system also isolates the terminal from all power fluctuations, surges and spikes.

Each trunk and telco circuit leading to the terminal is wired through a patch field. A monitor tap facilitates test of the circuits without disconnecting the line.

The grounding system is a separate fourth-wire copper bar with all equipment bonded to it in a non-loop arrangement. The facility is in an office environment and rests on a computer floor. Separate wall air conditioners with thermostats set slightly higher than the central HVAC system give sufficient backup during an air conditioner failure. The fire control system is Hylon gas, which extinguishes flames without damaging equipment or leaving any residue. The billing system is fully interfaced with the paging terminal.



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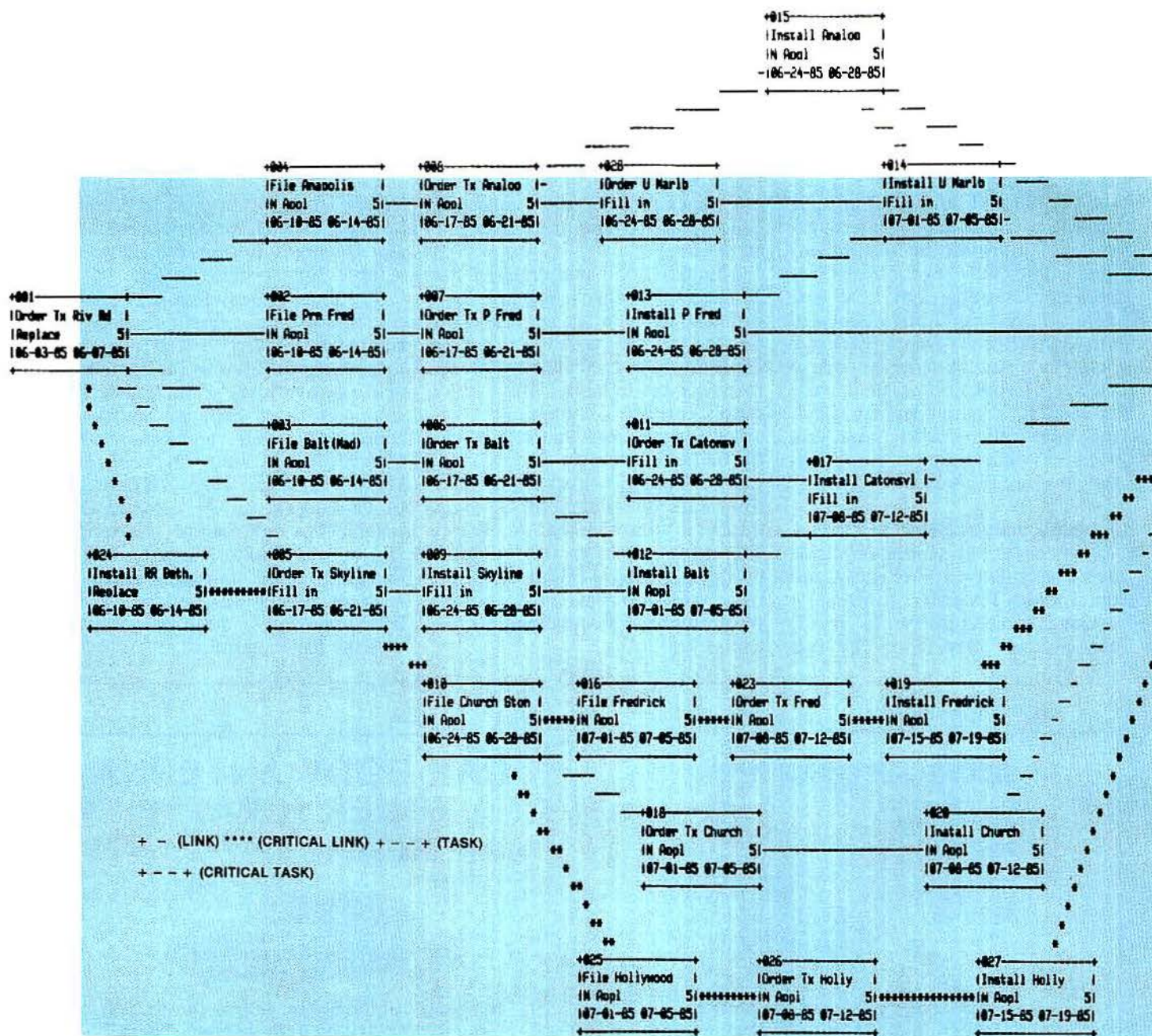


Figure 3. The program evaluation and review (PERT) technique was used to manage the project. Software packages that offer PERT include Harvard Project Management and SuperProject. Both are easy to learn and data can be transferred to popular software programs such as Lotus.

Throughout the entire project, the disciplining force that kept our focus on the overall objectives was the project management system. A project, whether as large as this one or as small as adding a transmitter or two to an existing system, is nothing more than a series of related tasks performed to reach a specific objective. The larger the project, the easier it becomes to lose sight of the objective and get hung up on individual tasks.

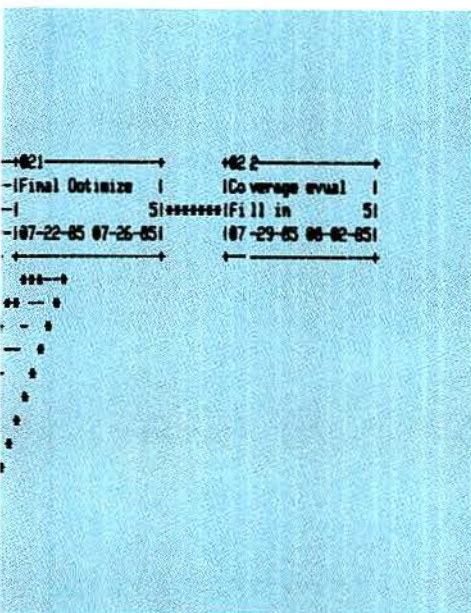
It also becomes essential to put on paper all the tasks, the time and cost of each task, and the order in which tasks must be performed. If this were not done, not only would it be difficult to monitor progress, but it would be easier to miss an important task.

This process also helps to save money. Ordering all goods and services long before you need them ensures you have everything you need to complete the project but certainly

costs your company more in monthly expenses, as well as idle inventory. The trick is to balance *what* you need with *when* you need it without forgetting any essential items. Program evaluation and review technique (PERT) and Gantt charts achieve that end.

The PERT chart is a series of boxes interconnected with lines. (See Figure 3 above.) Each box represents a task, when it is to be performed, and by whom. The lines





represent the relationship between those tasks.

For instance, our entire project, in its minimal form, could be three consecutively connected boxes labeled: "decide to build a paging channel," "build a paging channel," and "sell on the paging channel." The actual PERT chart for our project incorporated more than 200 tasks.

The second chart, called Gantt (named after its originator, Henry Laurence Gantt), is a series of events or tasks listed as time lines against a calendar. Other means of monitoring the project include task details and resource Gantt (resource is the person or service performing a task) as well as summaries labor and capital costs.

Once a model is put together it is not permanent. Quite the contrary, models always are being changed and revised. In fact, one of the benefits of this system is the ability to see quickly how a particular change would affect the overall cost and completion date.

In the old days, PERT charts were laid out by hand on wall-sized pieces of paper. (In fact, I hung them on the walls.) Fortunately,

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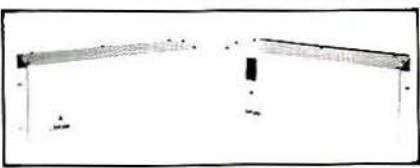
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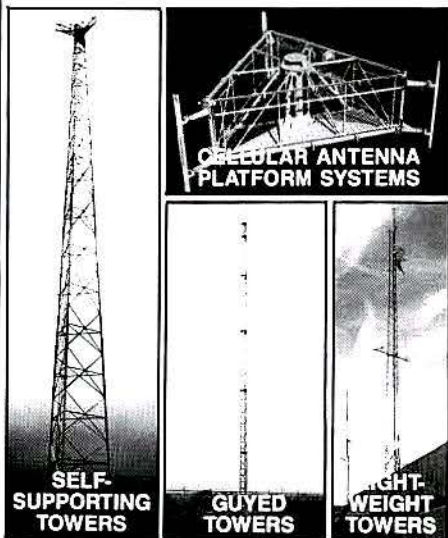
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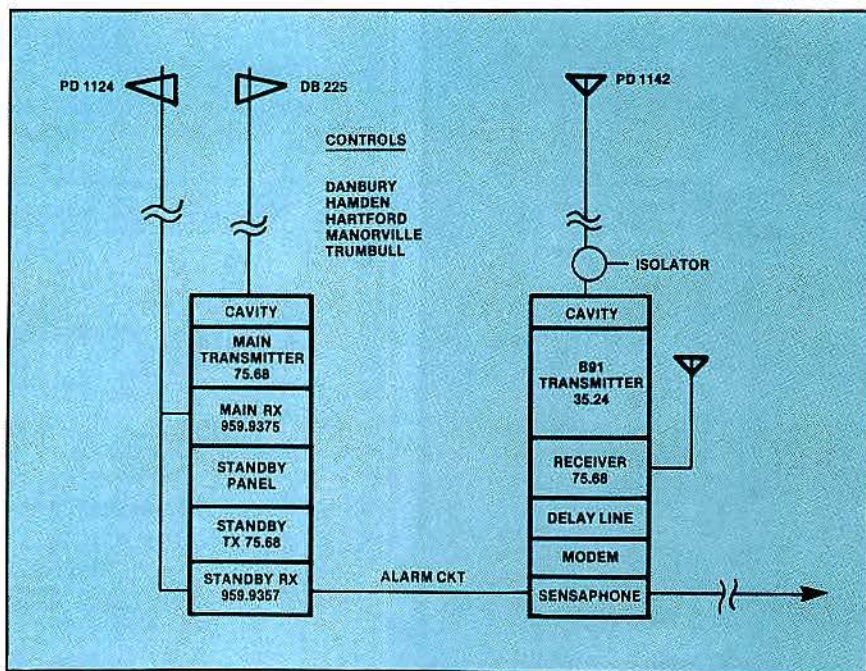


Figure 4. The diagram of a typical paging transmitter site shows the equipment complement selected for linking, site monitoring and control, and paging transmission.

several convenient software packages are available that neatly draw all the boxes and charts and calculate all the costs, schedules and changes. Two that I have used and would recommend are Harvard Project Management and Super-Project. Both are easy to learn, and data can be transferred to popular software programs such as Lotus. They certainly save many hours and many erasers.

### Equipment selections

Approximately eight months before the expiration of many CPs, the arduous task of vendor selection began. I already have indicated some of the vendors selected. The remaining major vendor was Motorola, which won the award for the transmission equipment. The company's B91 transmitters with link equipment were used throughout. (See Figure 4 above.)

For assurance that we would receive the proper equipment and that it would meet the manufac-

turer's specification, we reserved and exercised the right to make in-house inspections of the final product *before* it was shipped. We could inspect the product electrically and physically, thus eliminating any subsequent misunderstandings.

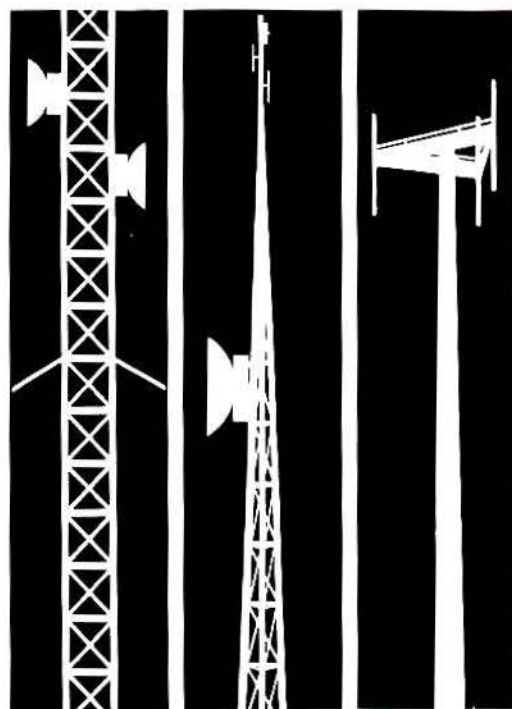
The initial pager selection included Motorola's BPR 200, Envoy and Optrx, all with Golay sequential code digital format. Golay is slower than RPC1 (formerly POCSAG), but it has more error correction. The added equivalent sensitivity the Golay format offered for the newly installed system was expected to help to overcome any areas that were not up to specification. As the system is fine-tuned, however, we will begin to take advantage of the higher RPC1 speeds.

### The installation begins

Much of the antenna and line installation work, along with final site lease negotiation and execution, began approximately two months before CP expiration dates. When



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possible, we negotiated leases that would become effective upon the installation of the equipment, but often this was not possible. The terminal arrived early. The transmitters arrived only six weeks before the CP expiration dates.

We rented temporary storage space along with receiving and delivery services from the storage company. This eased the daily problem of unloading trucks, accepting delivery and reshipping the equipment to the various sites scattered over three states.

At this point chief engineer Joe Mitchell seemed to be in 12 places at once. Actual radio equipment installation was accomplished by no fewer than eight different contractors with as many as four working at different locations simultaneously. Mitchell then would inspect each installation, inventory the equipment, photograph the site, perform a few brief measurements, check for FCC requirements, turn the equipment on, contact the FCC, and move on to the next site.

It certainly would have been simpler to have one contractor install all the equipment, but unfortunately that was impossible. Two companies installed approximately 10 sites, but others had to be installed solely by the owner or the owner's agent. Motorola controlled several sites and only its crews could perform the installations there. A few other sites were too far away for the preferred shops.

The logistics of what, where, how it got there, when it arrived, access and directions to the site proved to be monumental. Fifteen CPs that expired in November 1985 and 10 that expired in February 1986 were installed and licensed. For the next three months we tuned, and in some cases repaired, this initial system.

Some of the major problems solved then involved setting simulcast levels and offsets, TVI, intermod, equipment failures and a few others such as leaking roofs and

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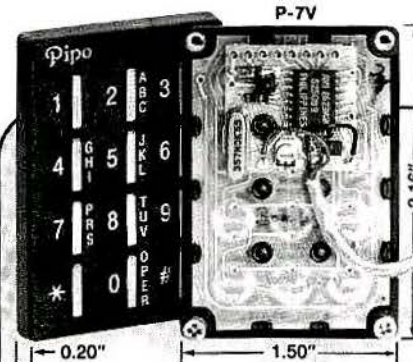


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lack of adequate site space. It seemed that Murphy's law was working overtime and solely on our behalf.

We tackled problems one by one.

After considerable debate about the proper frequency offset for frequency-shift keyed (FSK) modulation, we adjusted the simulcast offsets and delays.

Resolving TVI problems was much more difficult. In several cases, a harmonic of our fundamental caused the TV interference, especially in locations that housed CATV head ends or master antenna systems. In some of these situations the solution was to install a band-pass cavity on the base station output. Others required blocking filters in the CATV system input. Several required both. A few cases required changing the TV receiving antenna location relative to our antenna. In one or two instances we simply had to shut down and look for a new location.

We usually resolved intermod problems caused by a mix of our station and another by introducing a combination of cavity and isolator.


By April 1986, all of the originally planned sites were working correctly. Next we began finding dead spots in the coverage. The sales force began to sell service in areas with good coverage and began to give us information on coverage gaps.

Field tests with a calibrated antenna and spectrum analyzer helped to define the existing coverage area, as well as the RF energy level in questionable areas. We used computer-based models to screen potential sites. This saved enormous amounts of time and money in finding the best site for a specific area. Fortunately, almost all the sites installed after the initial 25 were fill-in sites.

The process has continued up through today. We currently have 50 operating transmitters. Two additional transmitters are planned to fill the last two identified gaps.

#### Trunks and numbers

As mentioned in the planning stage, we expected to start with 30 telco trunks originating from various central offices in the tri-state area. We were unprepared for the monumental task in dealing with Nynex, AT&T and New Jersey Bell.



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Telco circuit installation paralleled the transmitter installations. Most of the local New Jersey Bell trunks came in without a major hitch and usually were on time, but the major problem was in New York. Because the paging terminal is in New Jersey, we ordered New York trunks through AT&T, which had, upon receiving our orders 10 months earlier, accepted them without any problem. When delivery time came, however, apparently there was a problem.

Since the divestiture, neither company had written a tariff to permit the three telephone companies to hand off direct inward dialing (DID) numbers and trunks from one to another. We panicked. The more calls we made, the more people we spoke to, the less information we received. It finally was resolved when a special tariff was issued along with appropriate software for the telco switches. From the point of original order to the first trunk installation, 18 months passed. During the 18 months, we probably spoke to everyone in all three telephone companies right up to their presidents.

Each customer brings a special need, so each step in marketing the paging service redefines the system. Area identification, project description, computer models, installation and evaluation continue as we fine-tune and expand the paging system.

In view of the "total system approach," every change made to any part of the system, whether it be an additional site or an antenna improvement, changes the interrelationship between that part and the whole. Every step, therefore, must be planned carefully.

All indications now point to a complete success in the overall performance of the system. The system now is growing by more than 1,000 pagers per month from both direct and agent sales. Evaluations from customers, as well as our own measurements, indicate an unusually

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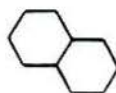
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icant differences from ours. This surprised many experts who predicted good suburban coverage and penetration (which we achieved) but poorer penetration in the cities.

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#### Operating the system

Operating and maintaining a system this large requires more than people and spare parts; it requires comprehensive maintenance and preventive maintenance plans. Large-scale operations cannot wait for customers to complain about service before taking remedial action, nor can they allow a slowly deteriorating situation to go undetected. To meet a commitment to providing excellent paging services, we installed status monitoring equipment and instituted a formal preventive maintenance program.

The status equipment consists of auto dialers at all link sites, as well as the majority of base stations. These devices automatically warn of equipment failures and monitor the equipment's operating conditions so the overall transmission process can be evaluated continuously. This helps to avoid the need for customer complaints to indicate system problems and can, in many instances, get repairs started even before the customers are aware of problems.

Once integrated into the transmitters, auto dialers can be programmed to report problems associated with low power, high VSWR, utility failure, link receiver operation, environmental conditions, and system activity. Also, we can poll the alarms periodically to generate a status report. Currently, we are integrating all the alarm units into a

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centralized control that will abort redundant alarms from failed equipment and automatically contact standby personnel with the alarm information.

The formal preventive maintenance procedure requires a field engineer to visit each site on a scheduled basis. Depending on the importance of the site, it can be as often as once a month or as infrequently as once every four months.

Basic transmitter meter readings are recorded at each visit, and more extensive tests such as link system fade margin measurements may be done less frequently. This is consistent with the philosophy: "If it isn't broken, don't fix it." Monitoring performance should not mean constantly adjusting and "fixing" what already is working fine. It means collecting and evaluating data to detect trends and start a repair before the problem affects service.

#### Documentation—the final step

The least rewarding step, but certainly not the least important, is final documentation of the system "as built." The entire system is being documented on four levels. The first is an overall block diagram of the entire channel depicting each site (a block), each link, and the terminal. The second is a block diagram of each site depicting every self-contained device, including, for example, transmitter, filters, duplexers, antenna and line. The third is an inventory of all equipment by site, listing serial number, model and frequency. The fourth is a list and diagram of all telco trunks and their connections to the terminal.

Log books containing this information, as well as maintenance records and any other information that would be useful to the field engineer, should be kept at each site. Without proper documentation, a paging system not only becomes difficult to repair, but in the case of personnel turnover, a disaster in the making.





# PLUG IN


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## Digital and packet Continued from page 121

sequence spread-spectrum signals. Geostar will succeed. The necessary technology is available, mature and being produced. All that is required to take the next step and make ISDN in the mobile environment a reality is an understanding of the fundamental scientific principles that govern communication along with commitment and perseverance to overcome the biases so deeply entrenched in the mobile radio communications industry today. 

### References

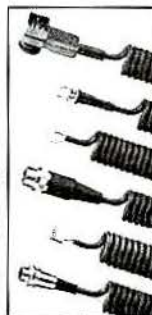
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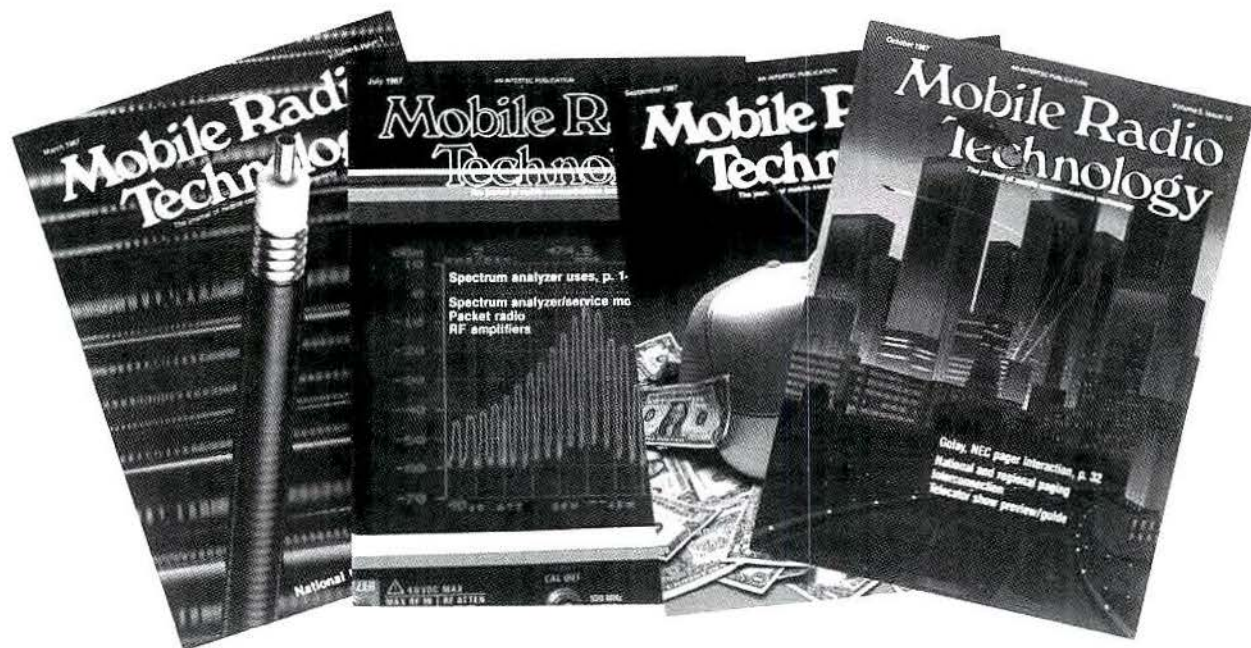
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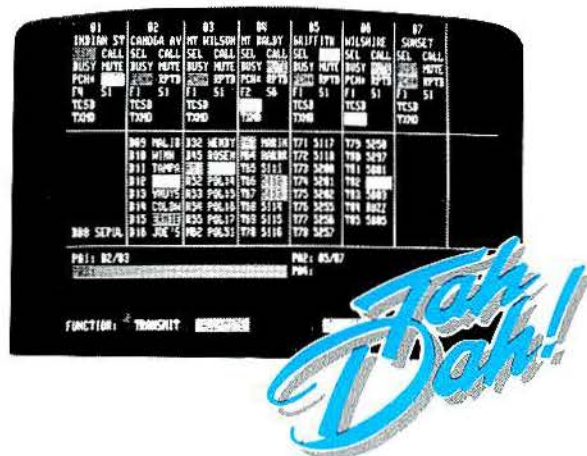


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Birham Industries/Orbacom Div.	38	37	609/482-1155	Modublox & Co. Inc.	133	133	619/456-0016
Blackhawk Terminals Inc.	86	88	919/872-7296	Morrison & Dempsey Communications	42	41	818/993-0195
Bogner Broadcast Equipment Corp.	54	54	516/997-7800	Moseley Associates Inc.	113	115	805/968-9621
Bomar Crystal Co.	56	56	800/526-3935	Multiplier Industries Corp.	48	48	800/642-2424
Broadcast Communications	76	76	800/833-3977	MX-COM Inc.	99	99	919/744-5050
BYTEK Corporation	139	144	800/523-1565	N.C.E./Power Group International	89	92	612/890-1360
CT Systems	13	10	800/245-6356	Nett-Workk Group	51	51	403/279-5055
Cal Crystal Lab, Inc.	78	78	800/854-XTAL	Neulink	86	89	800/551-8551
Canadian Marconi	71	70	514/341-7630	Norcomm Corp.	22	20	800/874-8663
Cellsmart Inc.	60	60	312/819-2500	Omnicon Electronics	117	119	203/928-0377
Celwave RF Inc.	17	14	201/462-1880	ORA Electronics	IBC	2	818/701-5848
Centurion International, Inc.	29	27	800/228-4563	Outlook Corp. of Taiwan/Hawa			
CES Inc.	11	9	800/327-9956	USA Inc.	43	42,43	702/731-4776
Cetec Vega	9	8	818/442-0782	Parkinson Electronics Co.	137	140	800/332-7003
David Clark Co., Inc.	49	49	617/756-6216	Pike & Fisher Inc.	44	44	301/654-6262
Coaxial Dynamics, Inc.	36	34	216/267-2233	Pipo Communications	137	141	916/644-5444
Coded Communications	65	65	800/325-0147	Polyphaser Corp.	20	17	702/782-2511
Com-Rad Industries	38	38	716/773-1445	Positron Industries	28	25	514/738-2200
Communications Associates	14	11	800/435-9313	Primus Electronics Corp.	128	131	800/435-1636
Communications Capital Group LTD	121	123	415/331-7600	R F Gain Ltd.	117	118	800/645-2322
Communications Specialists	BC	3	800/854-0547	Raven Radio Manufacturing Inc.	53	53	816/436-4435
Communications Systems Inc.	61	61	206/822-7479	Repco Inc.	39	39	305/843-8484
Connect Systems Inc.	19,78	16,79	213/373-6803	Rules Service Co.	86	90	301/424-9402
Console Systems	144	147	213/670-0610	Sales Unlimited	121	122	208/549-2501
Control Signal Corp.	97	97	303/989-8000	Savoy Electronics Inc.	127	129	800/327-1282
Controlonics Corporation	103	104	800/233-8639	SCE	23	21	516/822-9810
CTI Mfg. Co. Inc.	101	100	601/287-8081	Securitron Co.	138	143	408/263-6434
Curtis Electro Devices, Inc.	34	31	415/964-3846	Selectone Corp.	1	4	800/227-0376
Cycomm Corp.	66	66	800/523-8636	Setcom Corp.	85	86	515/965-8020
Data Signal Inc.	118-119	120,121	912/883-4703	Shure Brothers Inc.	45		800/257-4873
Decibel Products, Inc.	44	45	214/631-0310	Shure Brothers Inc.	140,141		800/257-4873
Digimax Instruments Corp.	74	73	619/576-7171	Sigtone Inc.	72	71	213/463-4474
Dixcom Inc.	111	114	305/563-1333	SMC	77	77	800/527-1079
Doppler Systems, Inc.	135	136	(602) 488-9755	Solid State Communications	3	5	415/785-4610
Dynascan	59	59		Spectrum Communications Corp.	135	134	215/631-1710
Electronic Circuit & Design Inc.	110	111	717/774-3193	Standard Communications Corp.	81	81	213/532-5300
EMR Corp.	36	35	602/978-5766	Sti-Co Industries Inc.	127	128	716/881-3287
Erie Electronics, Inc.	92	83	716/833-8400	Sweet Electronics	128	130	618/939-3870
Ferritronics	70	69	416/884-3180	Tait Two-Way Radio Inc.	106,143	107,146	713/984-8684
Freeman Engineering Associates Inc.	33	30	504/837-8330	TDI Batteries	102	103	800/323-7307
Fujitsu Ten Corp. of America	63	63	800/421-1996	Telefind	87	91	713/444-4442
Gamber-Johnson	115	117	800/826-0440	Teletec Corp.	40-41	40	919/556-7800
GRE America Inc.	96	93	415/591-1400	Telewave Inc.	67	67	415/968-4400
Hark Electronic Systems	26	23	800/367-4275	Telular Inc.	85	87	312/677-6000
Helper Instruments Co.	92,136	85,138	800/327-9308	Tessco	21	18	800/638-7666
Henry Radio	73	72	213/820-1234	TPL	28	26	213/256-3000
Hutton Communications	16	13	214/484-0580	Transcrypt Intl. Inc.	5	6	800/228-0226
ICOM America Inc.	15	12	206/454-8155	Trylon Mfg. Co.	138	142	519/669-5421
IFR Systems, Inc.	57	57	316/522-4981	TX RX Systems	108,109	109,110	716/549-4700
International Crystal Mfg. Co., Inc.	95	96	405/236-3741	Uniden Corp. of Am.	91	94	800/421-8894
ISC Cardion Electronics Inc.	31	29	516/289-6200	Unipage, Inc.	50	50	214/224-3509
JAN Crystals	34	32	813/936-2397	Universal Shelters	106	106	408/436-0299
JFW Industries	52	52	217/887-1340	URDC Measurement Inc.	125	125	801/561-9588
Kathrein Inc.	62	62	216/289-1271	Valmont Electrical Products	137	139	402/359-2201
Kenwood U.S.A. Corporation	7	7	213/639-9000	Vocom Products Corp.	135	135	312/459-3680
Kintek Custom Products Inc.	133	132	818/350-2136	W & W Associates	123	124	800/221-0732
Larsen Electronics Inc.	35	33	206/573-2722	Wavetek RF Products Inc.	83	82	317/788-5965
Lesmith Crystals	113	116	416/844-4505	Western Towers	125	126	915/685-6539
Lunar Industries	110	112	619/549-9555	Yaesu USA	55	55	213/404-2700
				Zetron Inc.	27	24	206/644-1300
				ZK Celltest Systems	139	145	408/248-8832

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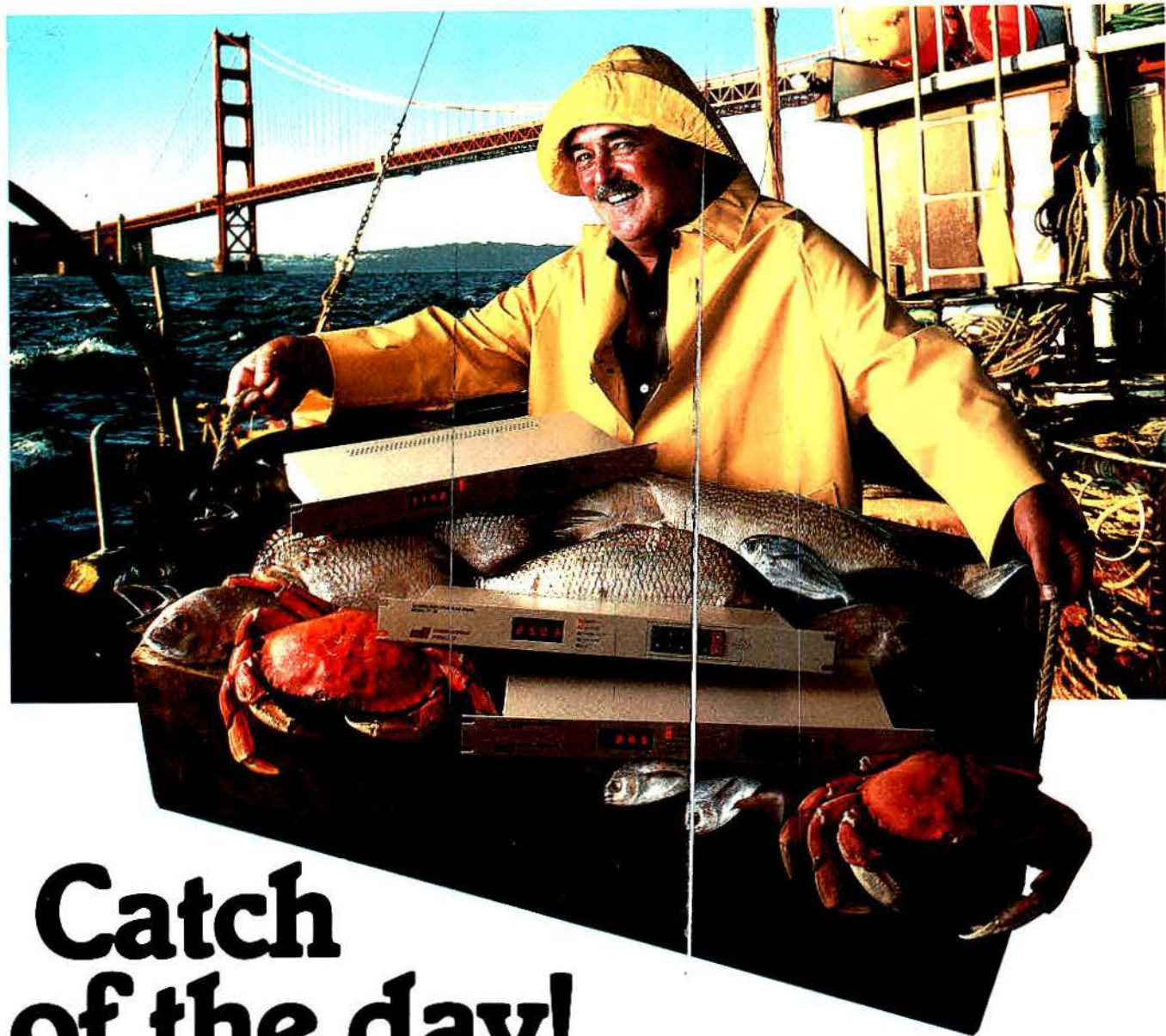


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